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THE NEW YORK CITY PASSENGER TRAFFIC for 1891, full returns for which have just been compiled, continue to show a large increase over the preceding year. The total number of passengers per year on all street and elevated lines is now nearly 431,000,000 per year, which is as nearly as may be *double* what it was only 11 years ago, in 1880. The full figures, to which we add 1880 and 1890 for comparison, are in *thousands* of passengers, as follows:

	1880.	1890.	1891
Elevated railways	60,832	185,834	201,202
Surface street railways.	150,390	218,565	229,651
Total.....	211,222	404,399	430,853
Population.....	1,236,999	1,710,715	1,772,000
Trips per inhabitant....	176.2	235.9	242.9

In 1890 the traffic of the Suburban Elevated Railway is not included, though it is for 1891, that line having been absorbed by the Manhattan Railway. Its traffic in 1891 was 4,488 *thousands* of passengers, and about 3,000, we believe, in 1890. The population we give for 1890 is that of the city enumeration, not the United States census, it being pretty clear that the former approaches more nearly to the true mean population.

ACCIDENTS TO PERSONS on the New York City surface and elevated railways aggregated last year 30 killed and 131 injured, against 19 killed and 139 injured the year before. The population of the city is in round numbers one-fortieth part that of the whole country. Consequently this is at the rate of 1,200 killed and 5,240 injured for the whole population, which is approximately equal to the total number of personal casualties from railway train accidents. But at 2 miles per passenger the total street passenger mileage of the city was last year 861,706,000, that for the entire country on ordinary railways being 12,521,565,000, or 14½ times as great.

A TUNNEL TO DIVERT WATER FROM THE GRAND RIVER to the eastern slope of the Rocky Mts., is the subject of a press dispatch from Fort Collins, Col. The water is to be used for irrigation and is to be projected by the Water Storage & Supply Co. Water is to be "conveyed to the plains by small creeks and prehistoric streams to a natural reservoir which will hold millions of gallons of water." The dispatch very correctly characterizes this as "the most gigantic irrigation scheme in the history of the West," and adds that the people of western Colorado threaten a lawsuit if the scheme is carried out, since the Grand River is their main source of supply. It does not seem probable that either side will need to engage counsel very soon.

IMMIGRATION is increasing largely, having been 45,172 in August against 37,387 in the previous year, an increase of 20¾%. For the eight months ending with August the increase is 24%. Italian immigration has fallen off about 25%, perhaps as an effect of the New Orleans incident. The principal increase is in Russian and Polish immigration, which is now about 24% of the whole. Not less than 416,570 immigrants have come to this country within eight months. It is generally expected, and we hope with reason, that measures to check this immigration, in its undesirable elements at least, will be passed by the next Congress.

THE MARSH LAND BACK OF ATLANTIC CITY, N. J., is to be reclaimed, and three powerful dredging machines are reported as ready to commence work next month. As outlined, the Hydraulic Dredging and Improvement Co. will use centrifugal pumps and force the material through pipes on pontoons to a bulkhead line. The 90 acres to be thus reclaimed will be used for building purposes.

THE HYDROGRAPHIC SURVEY OF THE GREAT LAKES, referred to as about to be made by the Hydrographic Bureau of the Navy Department in our issue of Oct. 17, seems to have little foundation. A correspondent calls attention to the fact that the U. S. Engineer Corps completed a thorough hydrographic and topographic survey of the Great Lakes in 1880 and issues charts to mariners from the U. S. Engineer's office at Detroit, Mich. We believe it is the case that the Hydrographic Bureau of the Navy is by law prohibited from making surveys of the navigable waters on the coast of the United States in order to prevent it from duplicating the work done by the Coast Survey. As the survey of the inland navigable waters of the United States is the duty of the Government engineers, it may be that the law also prohibits the Navy from duplicating this work.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision Oct. 26 at Thompson, near Glenwood, Minn., on the St. Paul, Minneapolis & Sault Ste. Marie Ry. A regular freight train was switching when it was run into by the second section or extra freight train. The caboose of the regular train was wrecked, and 5 persons were killed. The second section is said to have been running ahead of its time. A head collision occurred Oct. 22 near Murray's, Mo., on the Kansas City, St. Joseph & Council Bluffs R. R. A passenger and a freight train had orders to pass at that place, and the conductor of the passenger train seeing a freight train on the side track, gave orders to go ahead, without looking for the number of the freight, which was not the one he had orders to pass. In consequence that train was met later on. One man was killed, and several freight and cattle cars were wrecked.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On Oct. 21 the falsework of the second span of the Potomac River bridge at Hancock, Md., gave way, throwing the uncompleted span into the river. Two men were killed and one injured. On Oct. 24 a coal train on the Columbus & Western R. R. ran on to a burning trestle over Hatchett Creek near Goodwater, Ala.; the train broke through the trestle and 2 men were killed. On Oct. 24 a bridge or trestle on the Kansas City, Fort Scott & Memphis R. R. over Pearson Creek, near Springfield, Mo., gave way under a freight train and 23 cars were wrecked. On Oct. 25 seven trestles and bridges were burned on the Savannah division of the Central R. R. of Georgia. The fires are said to have been started by incendiaries.

MT. ST. ELIAS, in Alaska, has regained some thousands of its feet of height by the measurements of Mr. J. O. RUSSELL this year. In 1890 explorers in that region made measurements which reduced the height of the mountain to 15,428 ft. Mr. RUSSELL, in June last, measured a 3-mile base, and, while his calculations are not yet fully carried out, he says the height is between 18,000 and 19,000 ft. The computations of the U. S. Coast Survey, in 1874, made this height 19,500 ft. Mr. RUSSELL ascended the mountain to a height of 14,500 ft., thus surpassing his own record of last year and that of TOPHAM in 1888, which was about 11,500 ft.

THE ELECTRIC LIGHT ON THE SUEZ CANAL has reduced the average of time of transit through the canal as follows: Last year the average time was 24 h. 6 m.; in 1889 it was 25 h. 50 m.; in 1888 it was 31 h. 15 m.; in 1887, 33 h. 58 m., and in 1886 it was at least 36 h.

THE BRITISH COLUMBIA ARBITRATION CASE between the Canadian Pacific Railway Co. and the Canadian government has been finally settled by an award of $579,000 to the company, the claim having been for nearly $15,000,000 (its amount was never precisely formulated), and the expectation having been, probably, that from $4,000,000 to $5,000,000 would be awarded, as indeed justice seemed to require. The taking of testimony began in the summer of 1888, and an immense volume of it has been taken, probably much more than was ever before taken in any similar litigation. The substance of the claim, some further details of which are given elsewhere, was that the government had not so built the British Columbia section (which it undertook to complete and turn over free to the company, as part of the consideration for undertaking the enterprise) as to make it an ordinarily good and safe railway "up to the standard of the Union Pacific Railway as it was bound to do by agreement.

THE FAST "STATE TRAIN" from New York to Buffalo, 440 miles, began running on Monday of this week, starting from New York 1 min. 15 sec. late, and arriving in Buffalo 3 min. late, a net loss of 1 min. 45 sec. The train consisted of five coaches in all weighing 178 net tons, the engine and tender weighing 100 tons, 43 tons on drivers, as shown more in detail by the table in another column. This exceeded the proposed regular train by one car, a heavy private car weighing 88,400 lbs. It is more than likely, however, that it may became necessary to add another car to the regular train. Several successive miles were made in 53 seconds each, ending with a mile in 51½ seconds, all on a light down grade of about 20 ft. per mile. The schedule speeds for the train are precisely as follows:

	Distance miles.	Time, running.	Minutes stop.	Speed between stops.
New York—Albany.	142.88	2:45	5	51.95
Albany—Utica.....	91.67	1:48	2	50.60
Utica—Syracuse....	53.17	1:05	5	49.09
Syracuse-Rochester	80.38	1:24	2	57.41
Rochester—Buffalo.	68.42	1:24	..	48.87
Total	439.52	8:26	14	52.12
Average speed including stops.....				50.72

This is decidedly the fastest regular train in the world, besides having an extraordinarily long run. The "Royal Blue" train from Jersey City to Washington, the next fastest regular train in the world, makes the run of 230 miles in 4 h. 48 min. or 47.92 miles per hour, including five stops aggregating 14 min. Excluding these stops the mean speed, as we figure it, is 50.37 miles per hour, though it is usually given as 51¼ miles per hour. The fastest English train from London to Edinburgh now makes the run (400 miles) in 8 h. 30 min. or at the rate of 47.06 miles per hour, including four stops aggregating 35 min. Excluding these stops the speed is 50.52 miles per hour.

The weight of the train was as follows, in tons of 2,000 lbs.:

	Tons.
Engine (43 tons on drivers).....	60.0
Tender, loaded	40.0
Buffet, smoking car with baggage compartment.....	37.0
Two vestibule day cars, 27 tons each	54.0
Buffet parlor car.....	40.0
Private car.....	47.0
Total	278.0

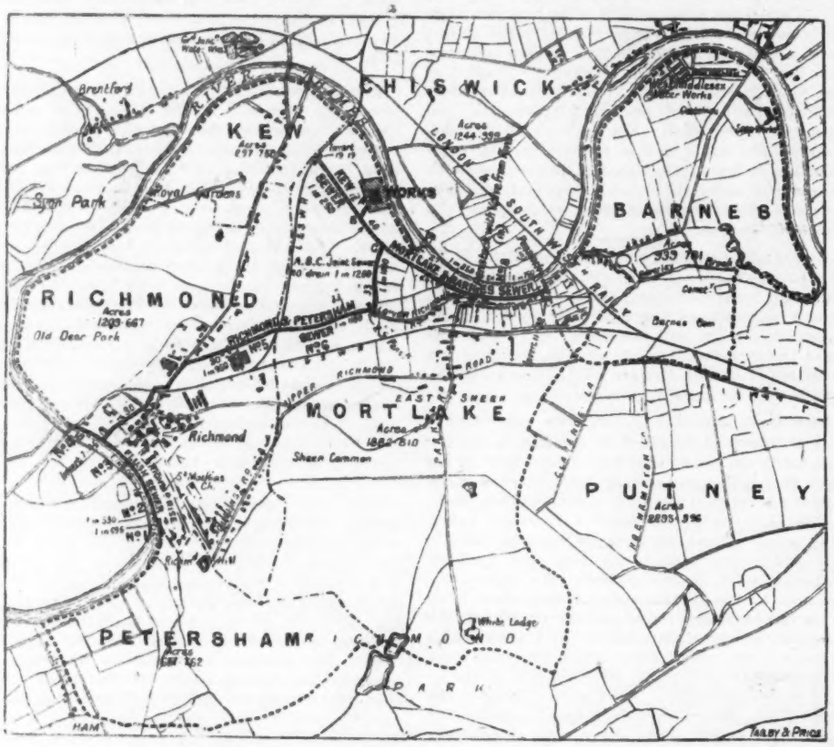
The private car was an exceptional load on the first trip, and the regular train is to consist of only 131 tons behind the tender, or 231 tons in all, but this weight is liable to be at any time increased by another car, weighing perhaps 40 tons, as the traffic may demand.

The Richmond Main Drainage Works, England.

(WITH INSET).

In a late issue *Engineering* minutely describes and illustrates these works, and from this we make the following abstract:

The works are intended to prevent the pollution of the Thames by sewage from Richmond, Mortlake, Barnes, Kew and Petersham, with an aggregate area of 4,983 acres and a population, in 1891, of 41,548. These towns combined form the Richmond Rural Sanitary Authority. Hitherto the sewage has been discharged direct into the River Thames, or partly retained in cesspools connected with the houses.



GENERAL MAP OF RICHMOND MAIN DRAINAGE DISTRICT.

The sewage, after having been collected in the system of sewers shown on the map, with their diameters and grades, flows by gravitation to a point on the Thames in the northeast corner of the parish of Mortlake, where the invert of the outfall sewer and pump chamber is 25 ft. below ordnance datum. The dry weather flow from the present population is estimated at 2,500,000 galls. per day, and the wet weather flow at 5,750,000 galls. per day. This disposal area covers 11 acres, of which only 7 acres are now in use. It is low-lying ground, with the surface only 2½ ft. above ordinary high water. An embankment protects the site against floods.

The collecting sewers vary from 12 ins. to 40 ins. in diameter; are circular and constructed, according to the situation, of stoneware socket pipes, laid in and surrounded with Portland cement concrete, cast-iron socket pipes laid in the same way, and in Portland cement concrete sewers lined with radiating Staffordshire blue brick inverts and gault brick arches. The stone and iron pipes were surrounded by 6 ins. of concrete and the brick sewers by 8 ins. of concrete. The iron pipes were used where the ground was treacherous, particularly along the river bank, where the ground showed a tendency to slip. The gradients were self-cleansing, varying from 1 in 250 for the smallest sewer, to 1 in 1,200 for the largest. The total length of main intercepting sewer was five miles, and the depth underground varied from 20 to 45 ft. The sewers were nearly all laid in the London clay, and they were generally constructed in tunnels down through this clay and worked from the shafts, which were later used for manholes and lampholes. Flushing is provided for from the Thames, at points where sewers commence, and the Holman-Keeling patent sewer gas destructor was used to insure ventilation. The size of the sewers was calculated upon the basis of excluding from them as much rainfall and subsoil water as possible, and they are only intended to receive a limited quantity of such water in addition to the sewage proper. They will dispose of the sewage of a population of 80,000. The outfall sewer has a discharging capacity of 11,000,000 galls. in 24 hours.

When the sewage reaches the disposal works it passes through a strainer of iron rods into the pump chamber, in which there are three sets of single-acting plunger pumps of 43 ft. lift. These pumps are driven by three 50-HP. compound, horizontal, intermediate receiver, condensing engines. Each set of pumps and engines will raise 4,000,000 galls. of sewage in a day, or 12,000,000 galls. in all. Steam is supplied by three Galloway boilers, each 18 ft. long by 6½ ft. in diameter, set on Livet's system.

In the pump chamber the strained sewage receives a small dose of milk of lime; it is then pumped to the surface and flows to the inlet channel for treated sewage. At the head of the channel is another strainer, and on its way to this channel the sewage receives a dose of a solution of sulphate of alumina, carbon and iron, and is thoroughly mixed by an agitator. From the mixing room the sewage flows to the precipitating tanks. The treated sewage channel is covered with tiles, set in Portland cement and carried on H beams set 3 ft. apart. The treated sewage is admitted into one or more of the precipitation tanks; as the tanks fill precipitation takes place and the effluent, now deprived of the whole of its polluting matter in suspension and nearly all that in solution, flows continually over weirs at the other end of the tanks. This effluent water is sufficiently pure to be discharged directly into the river; but it is still further purified, when required, by passing it through sand filter beds.

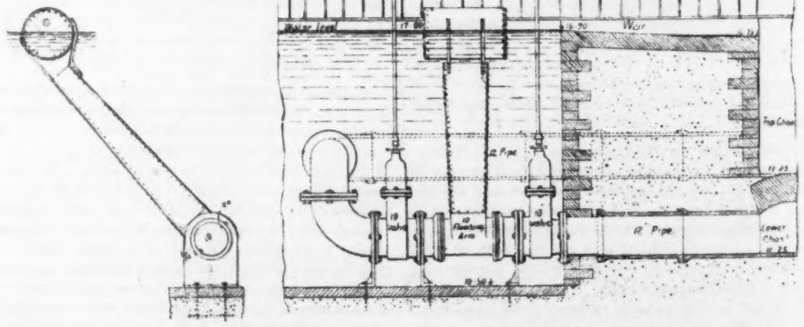
The precipitation tanks are entirely emptied once a day, by shutting off the inlet and drawing off the water by the floating pipe shown in the cut. Owing to the leve's, the upper part of the water is drawn off in the upper 12-in. pipe to the high level filter beds, and the lower part to the low level beds.

The "sludge" in the bottom of the tanks averages from 2 to 3 ins. in depth, and is 90% water. When the tank is "empty" about 6 or 7 in. of water covers this sludge, and as the tank bottom has a slope of 1 in 60, forming channels, the water and sludge, aided by sweeping, pass into a covered sludge passage, and into a sludge chamber under the press house.

In this sludge chamber precipitation still takes place, and the water rising to the top of the sludge is drawn off by a floating pipe and goes back into the pump chamber, to be treated over again. The sludge proper is lifted by pumps into iron receivers in the press house. These receivers each contain a charge for one press; a small quantity of lime is added, and it is forced by rams into the press. The result is a solid sludge cake 3 ft. square by 1½ ins. thick. The Johnson & Hutchinson 36-in. square sludge press is used. These sludge cakes can be stored without creating a nuisance, and are sold to farmers for manure or used in filling low land. The product is about 10 tons daily from the population of 41,000.

The entire cost of the works, including sewers, was about $800,000, and the annual cost of carrying on the works, pumping, &c., is estimated at $17,400. The Chief Engineer was Mr. J. C. MELLISS, of London.

Alfesil compound is the precipitant used at the Richmond main sewerage works, at Mortlake. It is manufactured by the Porous Carbon Co., of London, and is composed of carbon prepared by that company, mixed with certain proportions of soluble sulphates of alumina and iron. Porous carbon, also manufactured by the Porous Carbon Co., is used in the filter beds. Alfesil is also used in large quantities in the Coventry sewage works. Coventry is said to produce one of the worst sewages in England and most difficult to deal with effectually.



DEVICE FOR DECANTING CONTENTS OF SETTLING TANKS.

The Possible Effects of Earthquake Shocks on the Structures of the Nicaragua Canal.

Major C. E. DUTTON, U. S. Army, for a long time prominently connected with the U. S. Geological Survey, the author of several admirable works on the grand cañons of the Colorado, and who has made a special scientific study of volcanoes and earthquake phenomena, has made a report upon this subject in connection with their possible effect upon the structures of the Nicaragua Canal. Major

DUTTON accompanied Senator WARNER MILLER on his trip to Nicaragua last spring, and personally explored the country in question. The substance of this report may be given as follows:

The country between Lake Nicaragua and the Caribbean Sea, on the route of the canal, belongs to a past geological age, and, though the rocks are mainly volcanic in their origin, no recent volcanoes or lavas are known to exist in this region. Volcanic action has been wholly extinct here in the present geological age, and the surface lava has been decomposed into a red clay, with occasional rounded boulders of the original rock. Underneath this clay lava is found, sometimes in a good state of preservation, at other times decomposed; and interstratified with this rock and clay are found beds of volcanic ashes, called locally slate and tepetate.

The active volcanoes nearest to this part of the canal are in Costa Rica; while these are called active, the activity in some of them is shown by little more than the emission of steam at their summits or from lateral vents. Of the two separate chains of volcanoes in Costa Rica, the greater number have given no sign of activity in the present century and in most cases have been silent since the discovery of the country. The nearest volcano that may be really called active is Poas, about 58 miles from the proposed location of the Eastern locks. About 30 miles southeast of Poas is Irazu, the most active and forcible of these Costa Rican volcanoes. This volcano is about 63 miles from the Eastern locks, and at about the same distance is Turialla, another active vent.

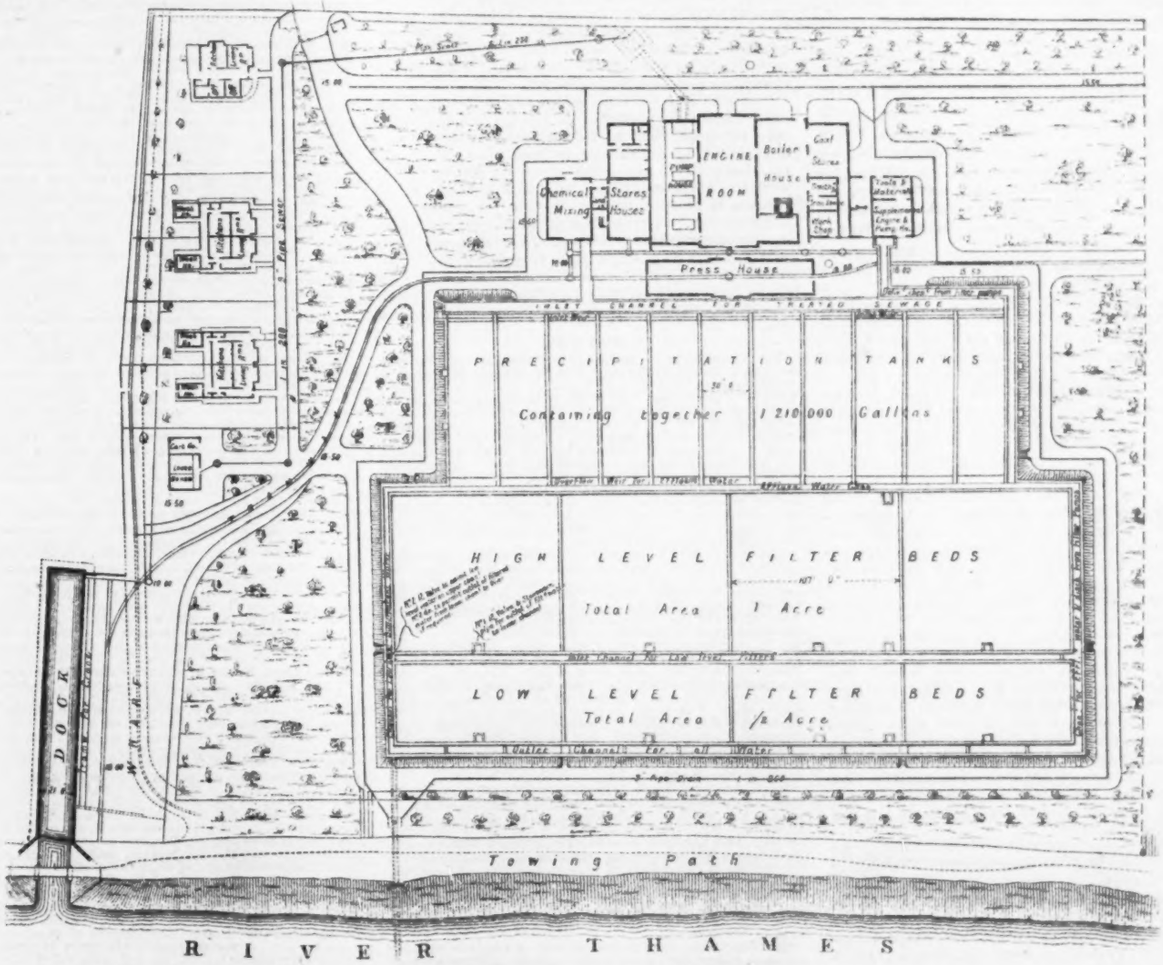
The second chain of Costa Rican volcanoes is longer and lies near the Pacific Coast, being only 12 to 15 miles back of Puntarenas. It contains but one or two cones which may be regarded as active, and Orosi, 38 miles south east of Rivas and the nearest to the canal, has given no sign within the memory of man now in that neighborhood. Major DUTTON passed near it and found no sign of eruption; it seemed to be an old cone in an advanced stage of degradation.

In the state of Nicaragua there is a single chain of volcanoes parallel to the Pacific and generally about 20 miles from it. The most southerly and nearest to the canal line are the twin peaks of Madera and Ometepe, in Lake Nicaragua. The first is apparently extinct; but Ometepe is active, having been in eruption in 1883. The next volcano in this chain is Mombacho, near the city of Granada. Lava streams from this volcano show that it has been in eruption within a very few centuries; though this eruption is not recorded. It is, however, one of the principal sources of earthquakes and tremors. It is a little over 40 miles from the proposed locks at Brito on the canal. Masaya, about 18 miles beyond Granada, was the scene of considerable eruption about a century ago, but it seems to have been attended with little violence, though a considerable quantity of lava was ejected. Next come Momotombo, at the head of Lake Managua, and Santa Clara, 20 miles beyond and north of Leon. The first-named has a record of two eruptions within the last century; but both are over 100 miles from the canal and outside of the limits of discussion.

The only recorded eruption of the extremely violent class in Central America was that of Coseguina, on the Bay of Fonseca, in 1835. All others were of moderate energy, causing no serious and widely-spread disasters. The ejections are largely in the form of scoria and ashes, though lava streams sometime flow.

Earthquakes are comparatively frequent in Nicaragua and Costa Rica, and a few have been destructive in very restricted localities. Major DUTTON proceeds to show at considerable length that the intensity of earthquake shocks at any given point is inversely proportional to the square of the distance from the centrum, or point of origin of the impulse, and that in this region all recorded earthquakes seem to have had their origin comparatively near the surface and in the immediate neighborhood of some of the volcanoes. As a consequence the effect is local, though some exceptional shock may transmit waves to the canal; but owing to the remoteness of the centers from the portion of the canal between Ochoa and the Caribbean Sea the probability that these waves will have force enough to materially injure the structures of the canal is too improbable, in Major DUTTON's judgment, to call for any special precautions against them. With respect to the portion of the canal including Lake Nicaragua and on to the Pacific, there seems to be a somewhat larger risk, but not large enough to cause any serious apprehension. The volcano of Ometepe is only 13 miles from the outlet of the canal into the lake, and about 21 miles from the Brito locks. Its eruption in 1883 was a somewhat forcible one, attended with strong tremors, and produced some cracks in the comparatively light walls of buildings in Rivas, half way between the volcano and the locks. Though that of 1883 was the first eruption since the conquest, earthquakes have emanated from it, and some of them were as forcible as the one in question; but none were measurably more so, as far as recorded.

With regard to the possibility of earthquake shock from Orosi, in Costa Rica, there are not enough data to warrant a very definite opinion. It stands in a wilderness inhabited by Indians, and if any earthquakes have originated there, the shock was so enfeebled by the time it reached the country settled by whites that it was harmless. The volcano of Mombacho, 35 miles north of the canal line, is a center of decided earthquake activity. But though shocks have been sharp enough to wreck houses and cause



PLAN OF PUMPING STATION AND DISPOSAL WORKS, RICHMOND, ENGLAND.

loss of life in Granada, they were harmless at Rivas, and this seismic centre may be regarded as too remote from the canal to cause apprehension.

Major DUTTON points out the fact that there is a tendency among those who have not made a study of earthquake phenomena to exaggerate the risks and dangers of so-called "earthquake countries." Their error consists in assuming the shocks to be frequent, wide spread and typical of the country. In truth, they are rare, even in the most afflicted regions; they are usually destructive only within relatively narrow limits, and it is seldom that one generation living on any one spot sees two destroying earthquakes in that locality. He concludes then that as far as the structures of the canal are concerned the risk of serious injury by earthquakes is so small that it ought to be neglected by the officers of the canal, and that the risks are still smaller on the Atlantic than those on the Pacific section.

The Independent (Storage or Primary Battery) System of Electric Motive Power.

The following is an abstract of a paper presented by Mr. KNIGHT NEFTEL at the meeting last week of the American Street Railway Association in Pittsburg, Pa. The paper and the discussion appear to show on the whole growing improvements, which may result in making this storage battery system a practical and commercial success. The system presents great possibilities and many advantages, we need hardly say, if the obstacles which have heretofore impeded its practical success can be overcome:

Owing to a variety of causes, the independent system has made less material progress in a commercial way than its competitors.

Primary Batteries.—So far, primary batteries have been applied only to the operation of the smallest stationary motors. Their application in the near future to traction may, I think, be entirely disregarded. Were it not a purely technical matter it might be easily demonstrated without knowledge of electro-chemistry, that such an arrangement as an electric primary battery driving a car is an impossibility. In view of the claims of certain inventors I regret to be obliged to make so absolute a statement; but the results so far have produced nothing of value.

Secondary Batteries.—The application of secondary, or storage, batteries to electrical traction has been accomplished in a number of cities with a varying amount of success. Roads equipped by batteries have now been sufficiently long in operation to allow us to draw some conclusions as to the practical results obtained and what is possible in the near future. The advantages which have been demonstrated on Madison Ave. in New York; Dubuque, Iowa; Washington, D. C., and elsewhere may be summarized as follows:

First.—The independent feature of the system. The cars are independent of each other, and are free from drawbacks of broken trolley wires; temporary stoppages at the power station; the grounding of one motor affecting other motors, and sudden and severe strains upon the machinery at the power station, such as frequently occur in direct systems; the absence of all street structures and repairs to the same, and the loss by grounds and leakages are also very considerable advantages both as to economy and satisfactory operation.

Secondly.—The comparative small space required for the power station. Each car being provided with two or more sets of batteries, the same can be charged at a uniform rate without undue strain on the machinery of the power station, and, as it can be done more rapidly than the discharge required for the operation of the motors, a less amount of general machinery is necessary for a given amount of work.

Another and important advantage of the system is the low pressure of the current used to supply the motors, and the consequent increased durability of the motor and practically absolute safety to life from electrical shock. It has been demonstrated also that the cars can be easily handled in the street, run at any desired speed, and reversed with far more safety to the armature of the motor than in the direct system. The increased weight requires simply more brake leverage. The modern battery, improved in many of its details during the last year, is still an unknown quantity as to durability. There is the same doubt concerning this as there was at the time incandescent lamps were first introduced. At that time some phenomenal records were made by lamps grouped with other lamps.

Similarly, some plates appear to be almost indestructible, while others, made practically in the same manner, deteriorate within a very short time. It is, consequently, very difficult to exactly and fairly place a limit on the life of the positive plates as yet. Speaking simply from observation of a large number of plates of various kinds, I am inclined to the limit of about 8 months, though it is claimed by some of the most prominent manufacturers, and undoubtedly it is true in special cases, that entire elements have lasted 10 months, and even longer. It must be remembered, however, that the jolting and handling to which these batteries are subjected in traction work increase the tendency to disintegrate, buckle and short circuit, and that the record of durability for this application can never be the same as for stationary work. A serious inconvenience for the use of batteries in traction work is the necessary presence of the liquid in the jars. This causes the whole equipment to be somewhat cumbersome, and unless arranged with great care, and with a variety of devices lately designed, a source of considerable annoyance.

The connections between the plates, which formerly gave so much trouble by breaking off, have been perfected so as to prevent this difficulty, and the shape of the jars has been designed to prevent the spilling of the acid while the car is running. The car seats are now practically hermetically sealed, so that the escaping gases are not offensive to the passengers. The handling of the batteries is an exceedingly important consideration. Many devices have been invented to render this easy and cheap. I have witnessed the changing of batteries in a car, one set being taken out and a charged set replaced by 4 men, in the short space of 3 minutes. This is accomplished by electrical elevators, which move the batteries opposite the car and upon the platforms of which the discharged elements are again charged.

The general conclusions which the year's experience and progress have afforded us an opportunity to make may be summarized as follows: Storage battery cars are as yet applicable only to those roads which are practically level, where the direct system cannot be used, and where cable traction cannot be used and applicable to these roads only at about the same cost as horse traction. I feel justified in making this statement in view of the guarantees which some of the most prominent manufacturers of batteries are willing to enter into, and which practically insures the customer against loss, due to deterioration of plates, leaving the question of the responsibility of the company the only one for him to look into.

DISCUSSION.

Mr. BAUMHOFF, of St. Louis.—The company which I represent has experimented with the storage battery, and I must say we have had no success. I believe our company was the second west of the Atlantic Ocean to undertake these experiments. We had two cars, each equipped with 120 cells, on an average grade of 2½%, the steepest grade not over 3½%. We were unable to get a greater mileage than from 18 to 22 miles out of each charge, and the charging of the cars required from 8 to 12 hours. We found also that aside from the leakage and the spilling of the liquid from the cells, the cells buckled and corroded, owing, possibly, to the acids. We expended a large sum of money in these experiments, but finally gave them up as a hopeless undertaking. The storage battery is certainly not a commercial success.

MR. NEFTEL.—I believe the experiments the gentleman refers to must have been made at least 4 years ago. In the past 4 years a great change has come over everything connected with the storage battery; in the plates, the type of battery, and the combining of the materials for the plates, and the shape has changed completely. The storage battery of this day, as manufactured by the leading companies, is an entirely new thing. Great progress is going on in this direction, and we are not justified in throwing the thing aside as a failure. I remember five years ago receiving a letter from the Thomson-Houston Company which I have preserved as a curiosity, asking me whether I thought electric traction would ever be successful and whether it would pay an electric light company to manufacture motors for electric traction. In the light of the developments made in the past in the general field of electric traction, we should not cast discredit on the storage battery.

Mr. BARR, of Newark.—On this question of storage battery I only wish to refer to the road in Philadelphia of which Mr. Sullivan is President. The Lehigh Avenue Passenger Ry. was built to operate storage battery cars. In May, 1890, the road started with 6 storage battery cars. In October, 1890, application was made to the City Council for the use of the overhead system, claiming that unless they could use it they would have to abandon the road. The Council refused permission to the company to use the overhead wire, and on Jan. 1, 1891, the storage battery cars were abandoned, and the road has since been operated by horse power.

Mr. VHAY, of Detroit.—I represent a road which has, perhaps, experimented with the storage battery system more than any other road in this country. A Woodward storage battery car was put on our road for about a year and a half. The plates in this battery were made with tubes, which seem to work better; no deterioration whatever. The system worked very well. The cars ran at the rate of about 12 or 14 miles an hour. The cost for coal was considerable, being $10 per day for one car. The trouble seems to be that it takes from 7 to 10 hours to charge these plates, and it is not possible to make over 35 miles a day; they make about 4 trips. Sometimes they can get into the house and sometimes they cannot. There were no grades, but some sharp curves. We thought that $10 a day for coal, $2.50 for the services of an engineer, and getting only 30 miles out of the battery was not much of a commercial success. We now have a road with cylinder underground filled with compressed air, and by cylinders connected with the car enough air pressure may be taken from the underground cylinder when the car stops for a passenger, to propel it half a mile. The people say that it runs like a scared cat.

Mr. RICHARDSON.—Does it take from 7 to 10 hours to charge a battery, and how long can it operate in running 35 miles?

Mr. VHAY.—It takes just as long to charge it as it does to discharge it, if you call upon the car to do the work.

Mr. NEFTEL.—I think it is a mistake to expect batteries to make a long run. If we have a perfected storage battery system it will not be a system in which cars will run for 100 or 200 miles; but it will be a system in which each car will make one trip, and then newly charged batteries will be put in the car. The batteries can be changed easily, and there is no earthly object in dragging them along for 30, 40 or 50 miles; it is taking along an unnecessary weight in lead.

Mr. E. A. SCOTT, of Philadelphia.—I am the representative of the company that has put in two successful plants in Dubuque, Ia., and Washington, D. C. We are now operating them as commercial successes. As Mr. NEFTEL stated, there is no more a necessity to run a battery 100 miles than there is of making a span of horses pull a car that distance. You can work a pair of horses until they drop in their tracks, and you can work the battery until it becomes exhausted, but there is no necessity for it in either case. If you want to know whether any road can succeed, take the successful roads that are running at the present time. Go to Washington and examine the road there, and you will be delighted with the way the cars run. As to the length of time it takes to charge a storage battery, it has been correctly stated that it takes as long to charge it as to discharge it. We calculate to run about 20 or 25 miles before we make a change in the batteries; and if they are run in that way on a road where grades do not exist beyond 5 or 6% there is no trouble. The question of how expensive the system is going to be is controlled by the question of how often you are going to renew the positive plates. There are 6 cars in Washington and 9 in Dubuque. They have been running since early part of May in Dubuque; about three months in Washington. On certain portions of the road in Washington they are making 15 miles an hour. If the experience of everyone connected with the cars is to be believed, they run regularly on their time, as regular as any other system, whether electric cable or horse. I noticed in the paper that was read this morning that the question of comparative economy in running is stated to be about that of horses. We believe, from what we know, that it is considerably less than horses, although we have no figures to show. We believe that in about a year it can be run in competition, so far as economy is concerned, with any overhead system. When we run a car about 20 miles at the ordinary street car speed, it will take about 2½ hours to charge the batteries for that service. You can charge the batteries so as to run 40 or 50 miles, or more; but practice has shown us that it is a very foolish thing to draw out the entire charge of the battery. The question of how long the battery will run before it will absolutely break down is not one to be considered for a moment, because it is very bad practice. That is the thing which destroys the cells. If the cells are properly used in this respect, the battery will last a long time—for many months. I know of one plant in Philadelphia in the lighting service that has run for 5 years without change.

Mr. MONTAGUE, of Yonkers.—I have seen within 3 months a storage battery car, not the Edco, that will take 85 passengers on a 16-ft. car and carry it up a grade of 10%, and do it easily and steadily. It takes 1½ hours to charge the batteries. They do not allow the batteries, as a rule, to run more than 20 or 22 miles; but on Decoration Day of this year 3 cars ran respectively, 42, 46 and 48 miles. When they came to the power-house, the engineer had gone home, and they remained outside all night. In the morning there was sufficient power left in the batteries to take the cars into the house. It takes about 30 seconds to change the batteries. These cars run on the level ground at a speed faster than most city governments will permit, and in mounting grades they go quite fast. On one occasion, as a car was mounting a grade, with 30 people in it, I got off and walked alongside the car, and it was not until it reached the top that I could keep pace with it. The grade was about 5%. Six cars are run.

Mr. RICHARDSON.—It seems to me to be the fair inference from what these gentlemen have told us, and from my own investigations on the subject, that the storage battery system seems only appropriate for roads running very few cars, and on a headway of perhaps 10 or 15 minutes.

Mr. HOLMES, of New York.—The gentlemen do not state what the power is that is put into the battery, and what is taken out. I think that point has not been covered. Assuming that we have 100 HP. coming out of the generator into the station. We will take a clear proposition, and it will not be denied that there is 10% of loss on the line of a trolley in the transmission of the power to a car in the street, so that but 90% is conveyed to the cars upon the street. Then there is a loss of about 25% motor, which reduces the net horse power developed by the motor under the car to about 68 HP. Now we will take storage batteries. Of the 100 HP. developed in the station there is a loss, if I understand it aright, of nearly 36% in passing the current through the battery; making 70% of the power in the battery of what was generated at the station. Then there is a loss of 25% in the motor, the same as in the trolley system, in the power furnished on the truck, so that we have 53% in the battery and 68% in the trolley. The difference in the weight of the battery car and the trolley car is vastly in favor of the latter, the relation being about 118 to 215; in other words, the power that you have to put in to move a battery car is nearly twice as much as to move a trolley car, and therefore the consumption of coal is nearly twice as great.

Mr. SCOTT.—I have not gone into the matter of figures. I can say this, however, as to the amount of power that is required to run a storage battery car. I took for one week the mileage of the cars on the Dubuque road, and also had measured at the dynamo the amount of power put into the batteries. I was enabled to get from the mileage of the cars the power it took per car mile, and it was a little less than 1½ HP. per car mile. If the gentleman can by a trolley system get it lower I shall be glad to know.

Mr. HOLMES.—We have got it down to 1 HP.

Mr. SCOTT.—The road has grades over 6%. If you will give us a level road I have no doubt we can do it with less power. I can tell you of one road where it averaged for 6 months, in a commercial way, eight-tenths of a horse power per car mile. I do not think you can get lower than that.

Mr. RICHARDSON.—It is quite evident that, as I said before, the storage battery is suited at the present only for small roads, with long headway. It certainly would not do for a road like the Third Ave., in New York, where the headway is about one minute. I suppose, also, with reference to roads that run like the Pleasant Valley, in Pittsburg, with four different lines, one of them starting four miles from its power station, and also like the Atlantic Ave. road, Brooklyn, of which I am President, which has 10 different lines, with 8 distinct depots and stables, it would not be applicable. The advantage of the trolley system is that all these roads could be run from one central power station, as I am told by competent engineers. I wish to express the intense disappointment I felt in visiting the Frankfort Electrical Exposition this year. There was not a single exhibit to indicate the progress of electric traction in America. Several American firms had exhibits of appliances for lighting, but so far as I could see there was nothing to indicate the great strides we have made in electric railway matters.

Mr. HOLMES.—My only object has been to see where we can obtain the most power from a pound of coal. I do not see it in the storage battery.

The Dependent (Overhead or Underground) System of Electric Motive Power.*

Underground Method.—Under this heading I have classified all methods of conducting or transmitting electricity to the car by means of any conductors or devices placed underground. I might possibly divide into two classes: First, continuous bare conductors placed in an open slotted conduit; Second, all other devices of automatic character which enable the contact piece or device on the car to take its electric current from sectional bare conductor or from bare metallic points, automatically made alive. There have been in this country at least four practical experiments with the first class, several hundred thousand dollars have been expended in testing it, and thousands additional in perfecting it, particular attention being given to the protection and insulation of the bare conductor. In spite, however, of all this refinement and study, practically nothing has been accomplished, and I have no hesitation in asserting that the continuous live conductor in an open slotted conduit is to-day a failure and that it cannot be made a success throughout our cities of to-day, its fatal weakness being our inability to prevent the conduit from becoming filled with water, mud, &c.

No large practical experiments have been made with the second class, but a large number of patents have been issued, and evidently there has been a great deal of careful thought study bestowed upon it. I, however, have no hesitancy in asserting that this class also will never prove a success, nor can it be made to work successfully throughout any of our cities to day. The reason for this is obvious. It is immaterial whether the automatic devices prevent the sections or contact points from being alive all of the time or not. If the conduit is filled with water or mud, and the points are made alive just as the car passes, there is bound to be a momentary grounding from these points. In other words, a point made alive in water with the other side of the circuit grounded, is just about as dangerous and bad as if it remained alive. It is true that the grounding may not be as severe, but still it will occur, and with a large number of cars throughout the city moving at the same time, causing, therefore, a large number of points to be alive, if any number of points were grounded through water it would cause a tremendous loss upon the central power station, and in all probability a complete grounding or short circuiting of the entire system. Numerous ingenious schemes have been devised to overcome this fatal weakness. None, however, have ever been put to trial. I have seen many, yet to-day there is no hope in this direction.

Surface Method.—The inventions covered by this method are somewhat similar to those employed in the conduit system, only in place of being in a conduit, they are placed upon the surface of the street. By far, the larger number of arrangements are based upon what might be called the "Interval" or "Point" system. Primarily this arrangement consists of an underground insulated conductor connected by means of taps to contact points on the surface of the ground, held in place by means of iron boxes and insulated therefrom. Upon the car is swung a long contact plate, extending practically from one end to the other. This plate is carried close to the ground, and is arranged to touch the points as it passes along. It is plainly apparent that if these contact points are always alive, then every time the street is covered with water, short circuits are inevitable. To overcome this, many automatic arrangements have been devised to cut these contact points into circuit by the car as it passes along, but all have the fatal weakness of a liability to ground or short circuits. I do not consider any of them practically possible. There is one more system which practically combines all these methods, and which obviates many of the objections. This has a slot between the rails and boxes with a contact device within, placed at proper intervals. Upon this car is a plow which passes along through the slot, and also a long contact plate or arrangement extending its entire length. The plow as it passes through the slot strikes a lever placed in connection with each box, which lifts for a distance of 6 or 8 ins. above the ground a piston carrying the contact piece proper This is made in the shape of a right angle hook placed within a vertically moving piston, and thoroughly insulated from it. As this is raised up, the long contact plate under the car passes beneath the hook and holds it up. The current is taken into the car as the plate slides along under the live hook.

Summing up the general results of the underground and surface methods, it certainly looks as if we could not expect very much from them in the immediate future. Much perseverance and money must be expended before as practical and certain a method as our present overhead method is attained. We surely are all anxiously and hopefully waiting for it.

Overhead Method.—There are two general methods of operating the overhead system. One is by having a continuous trolley wire wherever the track runs, and the second is to have this trolley wire divided into sections. For towns and for suburban traffic, the former is almost invariably adopted and carried out. The sectional trolley wire must be used for all city work. The methods of feeding the trolley wire vary with the method of arranging the trolley wire. With a continuous trolley wire the feeders are either extended from the station the entire length of the line, tapping into the line at intervals, or else separate feeders are run out from the station to certain predetermined distances, and there tapped into the trolley wire. When more than one feeder wire is needed in either case a repetition of the scheme is carried out from feeder wire to feeder wire.

With the divided trolley wire, there are two ways of accomplishing the feeding. First, to extend a feeder the entire length of the line and tap into the center of each section of trolley wire; or, second, to extend the feeder the entire length of the line and tap into both ends of each section. The question of feeder wires is one of great importance, and a difficult one to always economically solve for all conditions. The point, however, which the railway corporations should watch above all others is that they have enough. I have visited many roads where I found that the larger part of the trouble which they were complaining of lay in the fact that they did not have either sufficient trolley wire or track feeders. Railway officials are apt to object to feeders, because of their cost, and the placing of so many wires overhead, which is liable to bring them in conflict with the municipalities and the public. The question of having a sufficient number of feeders underground for the track, is one which they can have no valid or reasonable excuse for.

I strongly recommend as many ground plates as it is possible to have, not only at the station, but also along the line; brooks, bog land, water pipes, everything should be utilized for this ground circuit wherever possible. The plates can be made of sheet copper or iron, preferably the latter, and should have a superficial area of several hundred square feet. The wire connecting them to the track should be of sufficient size and very solidly attached to the plate and the rails. The continuous supplementary wire should in all instance be employed, and the rails bonded at least once. In no instance do I think it necessary or wise to place the track feeders overhead. I am strongly of the opinion that for large cities all feeders should be placed underground, as in Buffalo, Minneapolis and St. Paul.

Detailed information has been obtained for 137 roads (71 being Thomson-Houston and 66 Edison or miscellaneous), with 1,546 miles of trolley wire and 1,657 motor cars. In regard to trolley wires, of 137 roads, 99 were using copper wire (86 using No. 0, hard drawn), 28 silicon bronze, 8 both copper and silicon bronze, and 2 phosphor bronze. Of the 99 using copper not one dissents, while 11 of those using silicon bronze advise copper.

The proof is conclusively in favor of hard drawn copper wire and of the larger sizes, No. 0, B. & S. seeming to be the standard. In regard to the wearing, the universal testimony is that it is exceedingly slight. What wearing is observable is found to be at the switches or on the curves.

Serious mistakes have been made in the past by using iron flanged trolley wheels. These cut the trolley wire badly. Everything should be done to throw all the wear on to the trolley wheels. These are much less expensive than wire, and not so hazardous for the public if they give out. It would seem that with the ordinary brass trolley wheel the wear was about .001 of an inch to the passage of 65,000 cars. This is at the rate of 1 in every 6 minutes, for 18 hours per day, for one year. With only this wear the life of the wire would certainly be 20 years, unless through some process of crystallization it became more brittle. Undoubtedly, at curves and on switches the wear is somewhat greater.

Forty-one roads have their trolley wires divided into sections, and considered it necessary and advisable. These roads are in the largest cities or towns.

Regarding span wires, 49 report as using galvanized iron wire, 55 galvanized steel, 20 galvanized iron cable and one as using copper wire. The sizes range from No. 0 to No. 14. Comparatively few breaks are reported and no casualties.

My own experience has led me to adopt No. 4 B. & S. soft galvanized iron wire. Whenever a long span or curve is to be constructed I have had two of more of these wires twisted together into a cable.

I have found that a cable made of small wires is hard to joint, and it rusts much more quickly. Avoid joints, and use a ball fastener in attaching span wire to eyebolt. On the whole, however, I have concluded that iron is not the proper material to use in any shape. It will rust, and then your structure is weak. Pursuing my investigations into this matter, I found that a certain special quality of silicon bronze wire was the best. Tests of this wire in comparison to iron showed the accompanying table

	Diam.	Breaking weight.	Breaking weight per sq. in.	Elongation in six feet.	Twists in six feet.
No. 1 silicon bronze..	.210	2,550	81,800	.8%	37.1
Galvanized iron.....	.205	1,720	52,000	7.8%	19

I am aware that the price of this wire is five or six times as great as that of the iron wire, but as the total sum in either case per mile is small, I strongly recommend it. Some of this wire has been in service on the West End road in Boston for nearly a year. It certainly will never rust out. Guard wires are universally condemned, but are put as a compulsory protection from existing evils.

The descriptions of the various feeder systems are so vague I will not attempt to describe them. The average distance to which power is transmitted on these roads is about three miles. The greatest is 10.7 miles on the Tacoma & Stellacoom Railway, Tacoma, Wash. There are many, however, operating from 8 to 10 miles from the station.

The average speed of all the roads is 8.7 miles per hour, and the maximum 30 miles. The average grade is 6.7% and the maximum 13½% for 1,500 ft. at Amsterdam, N. Y.; 13 roads report grades of 10% or over. At Amsterdam a motor car with two 15 HP. motors climbs the maximum grade with a load of 52 passengers. Several roads run a motor and tow car, both loaded, up short grades of 8 or 9%. As to tests, only 32 of the 137 roads report having made any tests of engines, dynamos or motors, and 53 upon the overhead work. The roads should be continually testing circuits, stations and cars to insure economical operation and maintenance.

Storage Battery.—There is not to my knowledge to-day a single railway corporation owning and operating storage batteries solely for what there is in them, nor do I believe there ever will be. It is now claimed that litigation has interfered with their development. With ideality written all over the system, do you think that the powerful corporations who have spent hundreds of thousands of dollars in experiment would finally abandon them and devote their energies to a system which they have had to spend almost an equal amount in introducing and exploiting, fighting their way inch by inch throughout the country?

There are some grounds for hope in the direction of an underground or surface system. There is universal praise for the overhead system, and 6,700 cars operated over 3,000 miles of track in the streets of full 200 of our towns and cities, surely testify to its merits and value Of this number of towns and cities fully one-third have absolutely no other means of transportation. The objections are purely sentimental. Given, a city with all wires underground, where would be the objection to iron poles and a single wire for each track? The rails themselves would be more of a nuisance and more dangerous.

DISCUSSION.

MR. MANSFIELD.—In regard to guard wires, when there is only one trolley wire to protect we extend two light wires on each side of the trolley wire, about 18 ins. above it, and from 12 to 18 ins. on either side. We suspend the longitudinal wires running parallel with the trolley wire, it is insulated as perfectly as possible from the pole and from the trolley span wire, and the longitudinal or guard wires proper are also insulated as far as possible from the span wire. In the case of two trolley wires, the general practice, so far as I have observed, is to stretch three guard wires, two of them outside the two trolley wires and one over the center; all insulated perfectly from the other wires. We have never had any trouble from induction for the reason that they are insulated from the trolley wires. I think it is necessary to put them up, and as long as you keep them perfectly insulated from the trolley wires and extraneous wires which may fall, they will strike them instead of the trolley wire, and will dangle in the street as a dead wire which may be removed. I believe only one road used a sliding contact trolley, and I think that has been abandoned. I cannot say anything as to relative wear of rolling and sliding contact.

MR. BICKFORD, of Salem.—I do not agree with Mr. Mansfield on the size of his guard wire. No. 14 is too small, nothing short of No. 10 should be put up for a guard wire. My idea in the use of a No. 10 wire is not so much a question of its life, as its additional strength in supporting falling wires, especially when loaded with sleet in winter. On a portion of my lines I had fallen telephone and telegraph wires on my guard wires for a long distance and through it all we operated our cars without interruption, by using No. 10 steel wires.

MR. LITTLE, of Buffalo.—Is it not advisable to cut up the wire into sections of 1,000 or 1,500 ft. and put in circuit breakers, so that if any wire does fall the current will not be sent a great distance. This is done in Buffalo.

MR. MANSFIELD.—I would advise it; and it is done on many roads; the West End road of Boston, I believe, does it every 500 ft.

MR. WASSON, of Cleveland.—Mr. McKinstry, who is manager of the telephone lines in Cleveland, informed me that his telephone wires in the center of the city did not last much over a year, sometimes a year and a half. In our span wires we used a galvanized steel wire, and at the

* Abstract of a paper by Mr. G. W. MANSFIELD, presented at the convention of the American Street Railway Association, at Pittsburg, Pa., last week.

end of a year and a half they were rusted to such an extent that we dared not tighten them up. We have a chemical works and an oil works in Cleveland, and we do not know whether or not it is due to the gases that come from these factories. I believe our road was the first to use the soft drawn copper wire for span wires. The reason for using this in preference to hard drawn wire or silicon bronze was due to the fact that silicon bronze when first made was very brittle; strong if pulled straight, and if it became kinked or nicked it would break like a pipe stem. We use a soft drawn No. 4, the same as for the ground work; that has been up now over a year and there has been no perceptible elongation or stretching or siding. When the storage battery will enable us to take down the span wires we will have something for scrap; the steel for span wires will be worth little apparently. The copper wire will not corrode, and the only objection I have ever heard to it was the initial expense, and the possibility of it stretching.

Mr. RICHARDSON.—I have had submitted to me a copper triangle, triangular tube, if I may so call it, intended to cover over the trolley wire, and to guard it thoroughly from any interference with wires that might otherwise come in contact with it.

Mr. MANSFIELD.—I have looked into a great many methods of protecting the trolley wire outside of the stringing of additional wires, but I have not seen any which in my judgment would lead me to adopt it upon any road where my advice was asked. The trouble is that most of these devices if you can hold them in position over the trolley wire, will walk and twist, and unless they are made very large the trolley wire may swing to one side or the other; they entail heavy span wires and an additional strain upon the side poles for their support. In the winter time the top of these devices will be covered with a large accumulation of ice and snow, which throws a greater weight upon the span wires and strain upon the side poles for their support, then again they are difficult to put in place and maintain in place. That is the result of my observation, and I do not think there is anything as good as what is generally accepted and used to-day.

A Birdseye View of the World's Columbian Exposition.

The accompanying engraving gives an excellent general idea of what we may expect to see at Chicago in 1893. It is taken from a photograph, not of the buildings themselves, as those acquainted with the progress of the work will readily understand, but of a model of the grounds and buildings on a scale of 1/8 in. to 1 ft., constructed by Phillipson Brothers, of Chicago. The area represented by this model is 673 acres, and the floor space occupied by it is 47 × 92 ft. The point from which the photograph of the model was taken corresponds to that which would be occupied by an observer of the real exhibition in 1893, stationed northeast of Jackson Park, about half a mile from the lake shore and 1,050 ft. above its surface. Whether the flying machine inventors will be able to take passengers to gaze on the exposition in 1893 from this point remains to be seen.

We are indebted for the engraving and for the following description to the new Chicago journal, *Electricity:*

In the middle of the picture the large building with a dome is that of Manufactures and Arts, said to be the largest building in the world. It covers a ground space of 788 × 1,688 ft. The engraving represents the building as originally planned—a quadrangle with interior court, but the demand for space was so great that it was decided to arch over the court, bringing the whole under one roof.

Directly in front of this building, but on the further side of the lagoon, not represented, is the site of the Government Building and on this side of the canal is located the Fisheries Building 163 × 363 ft., with circular aquaria at either end 135 ft. in diameter. To the right of this in the foreground is the wooded island in the north end of the lagoon; and the turreted structure at the other end and to the [illegible] of the Manufacturers and Arts is the Electri[illegible]

In co[illegible]th its neighbor it looks insignificant in size, and [illegible] have maintained from the start that it was inade[illegible] to the purpose. Its dimensions are, however, 350 × 700 ft.

A BIRDSEYE VIEW OF THE WORLD'S COLUMBIAN EXPOSITION.

The next two buildings to the right are those of Mines and Transportation, covering respectively areas of 350 × 700 ft. and 250 × 960 ft. The domed building on the right is Horticultural Hall, 250 × 1,000 ft., and that in front of it, occupying a space of 200 × 400 ft., fronting on Midway Plaisanee, will contain the Women's exhibit.

The two large structures in the far distance are the Agricultural Building on the left, 500 × 800 ft., with an annex 300 × 500 ft., and Machinery Hall, 500 × 1,400 ft., the two being connected by an arcade.

To the north of the Machinery and to the south of the Electricity and Mines buildings is situated the Administration Building, 225 × 225 ft., surmounted by a dome rising to a height of 300 ft., visible in the middle distance. In front of this will be placed the statue of Columbia, and in a semi-circle to her left will be erected the 13 St. Gaudens pillars, 65 ft. high, representing the 13 original states.

The wooded territory in the immediate foreground traversed by avenues, has been parceled out to the various states for their state buildings. These are at the north end of the grounds.

Just beyond the cape on the left of the picture a breakwater will be constructed, within which will be placed the Naval Exhibit and still further in the distance to the left of the St. Gaudens columns another breakwater will be constructed, inclosing a harbor for pleasure craft, at the lake extremity of which will be located the Casino, 172 × 300 ft.

Engineering at the World's Columbian Exposition.

Among the series of congresses which it is proposed to arrange for at Chicago during the Exposition season of 1893, engineering seems likely to have an important place. The official "Department of Engineering" includes the construction of railways, canals and tunnels; river and harbor improvements, water works, sewerage and drainage, bridges and structures; and mechanical, mining, metallurgical, military and naval engineering generally. This department is under the charge of a local committee composed of the following gentlemen: E. L. CORTHELL, Chairman; D. J. WHITTEMORE, Vice-Chairman; E. M. IZAED, WILLIAM FORSYTHE, C. L. STROBEL, ROBERT W. HUNT, JOHN W. CLOUD and JOSEPH HIRST. This committee will be assisted by an Advisory Council, which is to be made up from the eminent engineers of the world, through whose co-operation the General International Engineering Congresses will be assembled.

The following report has been made recently by Mr. CORTHELL, the Chairman of the General Committee, who was appointed by President BONNEY, as the Special Commissioner of the World's Congress Auxiliary abroad:

CHICAGO, Oct. 5, 1891.

Hon. C. C. BONNEY, *President of the World's Congress Auxiliary of the World's Columbian Exposition.*

DEAR SIR: I have just returned from Europe, where I have been engaged during the last four months in making examinations of railroads, railroad terminals, harbors, universities and technical schools. Also in inviting, personally and by letters, the engineers of Europe to the International Engineering Congress which it is proposed to hold here in 1893 under the auspices of the World's Congress Auxiliary. My professional intercourse with many eminent engineers gave me a good opportunity, whenever I met them, to explain the object and the scope of the congress. The position as chairman of the general committee of the World's Congress Auxiliary on Engineering Congresses, and that of chairman of the Executive Committee of the general committee of the engineering societies of the United States and Canada, enabled me to bring this subject in an official manner before engineers and before their various associations. I invited personally and by letter, 36 engineering associations. Although most of the associations were in vacation from June to October, yet I have received from many of the secretaries, and personally from several of the presidents and other members of their councils, not only an assurance that their associations would accept the invitation to participate in the congress, but also expressions of the great interest which these important

associations of engineers have in the proposed congress. Not only the engineers composing these associations, but the engineers of the governments, especially of France, Germany, Holland and Belgium, evinced the greatest interest in our congress. The interest in the congress among the engineers of Great Britain and the officers of the great engineering societies of that country was not less than that shown on the Continent, and I received here also promise of support for our congress, and the expression of a desire to attend it, which was universal. I might say here that in all the countries which I have visited nearly all the engineers whom I met promptly signified their intention of coming to the congress and the exposition. By invitation I attended the annual convention of the Mechanical Engineering Society of Germany, held at Dusseldorf. This society numbers about 6,000 members, the council of which decided to accept our invitations to take part in the congress. I was also informed by the President of the Society of Civil Engineers and Architects of Germany, which numbers about 6,000, that they had acted on the invitation and had gladly accepted it. Letters have been received also from engineering societies in countries which I was not able to visit expressing a great interest in the proposed congress, and assuring me that their councils would act upon the matter immediately after their vacation.

There has been received also a communication from the president of the Mexican Association of Engineers and Architects, with the information that the association is glad to accept our invitation and that it will send delegates to the congress. It is proper for me to state that while in Europe I was in communication with the Director General, the Superintendent of Construction and the Chief Engineer, who sent me from time to time information of the progress of the work connected with the Exposition, which enabled me to reliably inform all those whom I met in regard to the progress of the work. You will readily see that I would reach places and people which others might not. It would be premature at this time to give names of those who have been of service to me while abroad, but I can assure you that I have been greatly assisted by members of the engineering profession in all the countries which I visited, and have received assurances from them that they would take up the work where I left it and seek by all means in their power to promote its interests. I am yours, respectfully,

E. L. CORTHELL,
Chairman of Gen. Committee on Engineering Congresses.

Railways in Australasia.

The building of 12,000 miles of railways in Australasia has cost about $540,000,000, or an average of $45,000 per mile. In a recent issue of the London *Railway News* there is an interesting sketch of the growth of the railways in this group of islands and states and from this sketch we make the following abstract:

The area of the Australasian colonies is 3,161,000 sq. miles with, a population of 3,786,000. Assuming that a railway opens out to some extent land 20 miles on each side of the line, it is seen that only 480,000 sq. miles out of the above total area are even remotely effected by railways. While the development has been slow as compared with the United States or even the Argentine Republic, it must be remembered that these roads have been mainly built by the governments with money borrowed in England and on which interest is paid.

The following table shows the mileage at periods from 1870 to 1891, on the Australian continent and in Australasia, that is, including New Zealand and Tasmania:

	Australia.	Australasia.		Australia.	Australasia.
1870	948	948	1886	6,769	8,881
1875	1,631	2,323	1887	7,385	9,544
1880	3,421	4,851	1888	7,945	10,137
1885	6,134	8,045	1890-1	9,679	12,001

The actual mileage of railways for each colony and the date of the opening of the first line is given as follows:

	1890-1.	1885.	1870.	First line opened.
Victoria	2,762	1,674	274	Sept. 14, 1854
New South Wales	2,192	1,577	335	Sept. 25, 1855
Queensland	2,112	1 434	206	July 31, 1865
South Australia	1,810	1,063	139	April 16, 1856
Western Australia	813	194	...	1873
New Zealand	1,948	1,654	50	Dec. 1, 1863
Tasmania	374	257	...	Feb. 19, 1871
Total miles	12,001	8,045	948	

It is unfortunate that in the construction of railways in Australia a uniform gage was not adopted which would have greatly facilitated interchange of traffic where different systems meet, and would have been better in many other ways than the present irregularities in this respect. All the Victorian lines are constructed upon a gage of 5 ft. 3 ins. This is also the standard gage in South Australia, but it has not been strictly adhered to in that colony, as over 700 out of 1,500 miles have been built on a 3 ft. 6 ins. gage. In New South Wales a 4 ft. 8½ ins. gage is the standard, but a private line connected with the Victorian system is on the 5 ft. 3 ins. gage. In Queensland, Western Australia, Tasmania and New Zealand all the railways have been built upon a gage of 3 ft. 6 ins.

The gage forms, of course, an important factor in comparing the cost of the railways of the various colonies, and must be taken into account in comparing the subjoined figures giving the cost per mile of the various systems.

	Cost per mile 1890-1.
Victoria	$64,755
New South Wales	72,795
Queensland	32,100
South Australia	31,785
Western Australia (1888)	21,770
Tasmania (1888)	42,180
New Zealand	38,760

In 1888, taking the continent of Australia as a whole, the capital cost of railways averaged $49,965 per mile, and the proportion of net [illegible] to cost of railways was 3.55%. Combining t[illegible] the Australian continent with those o[illegible] and New Zealand, the capital cost aver[illegible],565 per mile, and the proportion of net revenue to cost was 3.33%. Considering the important part played by the railways in opening out new districts, and developing the resources of the colonies, these are results for which the Australasian Government may fairly claim credit, and which must be set against the comparatively slow extension of the systems.

A full account of the railways of Australasia was given in ENGINEERING NEWS, March 30, 1889.

The Largest Dry Dock on the Lakes.

The illustration in this issue, taken from a photograph, shows a general view of the largest dry dock on the great lakes. It is situated in Detroit and was built by the Detroit Dry Dock Co.

The under soil is fine blue clay and into this about 2,000 piles were driven to firmly support the sill timbers and sides of the dock. The inside dimensions are as follows: Length, 378 ft.; width on top, 91 ft.: width at opening, 78 ft.; opening on mitre sill, 54 ft.; width on floor, 55 ft.; depth of water over keel-block and over sill, 16 ft. 6 ins.; from top of keel blocks to floor of dock, 4 ft. 6 ins.; from water line to floor of dock, 20 ft. 6 ins.

VIEW OF DRY DOCK AT DETROIT, MICHIGAN.

The keel and bilge block are 5 ft. from center to center, averaging 5 ft. high, thus leaving plenty of room under a ship for the movements of workmen in making any necessary repairs to her bottom. There are two wells 12 ft. deep situated at each end of the dock, with cranes above them for hoisting out and replacing wheels, &c. The caisson gate which, when closed, shuts off the ingress or egress of water, is of steel constructed at the company's steel ship building plant, at Wyandotte, Mich. It is 12 ft. beam, 79 ft. 5 ins. long, with five 30-in. valves for flooding the dock, which it is estimated it will do in 20 minutes. Time required to pump the dock out is 1½ hours. The whole dock is surrounded with a puddling wall filled with blue clay 5 ft. thick, and extending down below the old river bed, which completely shuts off all water from leaking through the sides.

The pumping plant, which is very complete, consists of two centrifugal pumps with 30 ins. discharge each. These are driven by two 150-HP. independent compound Westinghouse engines. These pumps are in a well 22 by 11 ft. inside and 35 ft. deep, the water passing from the dock to the well through a brick tunnel 5½ ft. in diameter and 55 ft. long. The steam for the engines is supplied by a battery of three boilers, 5½ ft. in diameter and 15 ft. 6 ins. long, built by the Dry Dock Engine Works. The fuel is oil, and the whole pumping plant is housed in a two-story brick building 34 by 81 ft. A dynamo-room is provided where an electric light plant will be put in during the coming winter, which will supply the entire ship-building plant with light. The second floor of the building will be utilized by the workmen at noon and other hours, when work may be temporarily suspended, and will be fitted up with an eye to their comfort.

This dock is large enough to take in any boat now upon the great lakes, and has been designed especially for the wide railway car ferries and passenger boats with their overhanging guards and paddle wheels. The cost of this dock was upward of $200,000. There has also been added to the Detroit Dry Dock Company's plant, a pair of steel shear legs for hoisting boilers, engines, spars, &c. from and into boats. They are located just above the new dock, are 100 ft. high, and have a lifting capacity of 100 tons.

The contractor for the dock was Mr. A. J. DUPUIS, who carried on the work under Mr. J. C. PARKER, the superintendent of the Orleans yard of the Detroit Dry Dock Co.

Legal Decisions of Interest to Engineers.

Coupling Cars in Motion.—Though attempting to couple cars when the engine is running at a speed of 15 miles an hour is apparently not dangerous, but reckless, yet if it be true in the experience of engineers and railway men that it is safe, provided that the engine is properly managed, and if the failure in question resulted solely from the fault of the engineer in manipulating the engine, the high speed will be no obstacle to a recovery by the car coupler for a personal injury sustained by him in making the attempt. Though to non-experts its truth would seem in a high degree improbable, if not impossible, yet, there being direct and positive evidence tending to support the theory of safety, the court erred in granting a nonsuit. (Rebb v. East Tenn., V. & G. Ry. Co., Sup. Ct. of Ga., 13 S. E. Rep., 566.)

Location of Turntable.—Where a turntable is located on land belonging to a railway company, 600 ft. from a public highway, the company is under no obligation to keep it locked because it is an attractive object to children, and a child injured while playing thereon cannot recover damages from the company. (Daniels v. New York & New England Ry. Co., Sup. Jud. Ct. of Mass., 28 N. E. Rep., 283.)

Construction Lien in Georgia.—Under the Georgia Code, contractors to build railways are entitled to liens upon such railways, but each lien is upon the whole railway to which it applies. There is no provision of law allowing a contractor to set up and enforce a lien upon a part of any railway, though such part may be all of the road which he constructed or aided to construct. As under Section 1,990 of the Code, the verdict must set forth the lien allowed, and the judgment and execution must be awarded accordingly, a verdict and judgment which attempt to set up and enforce a lien upon their face, so far as the contractor's special lien is concerned. (Farmers' Loan & Trust Co. v. Candler, Sup. Crt. of Ga., 13 S. E. Rep., 560.)

Standard Rail Section and Track; South Australian Government Railways.

We present in this issue the drawings of the standard type of track of the railways of South Australia, for which we are indebted to Mr. A. B. MONCRIEFF, M. Inst. C. E., Engineer-in-Chief. The railways are owned and operated by the government of the colony, and have a gage of 5 ft. 3 ins.

With the increasing traffic and speed on these lines it has been found necessary to increase the weight of the rails beyond the former standard of 61 lbs. per yd. The present standard rail weighs 80 lbs. per yd., and is of decidedly American appearance in section. It has vertical sides to the head and web, and sharp bottom corners to the base, but the ties being of hard wood are not liable to be cut by the

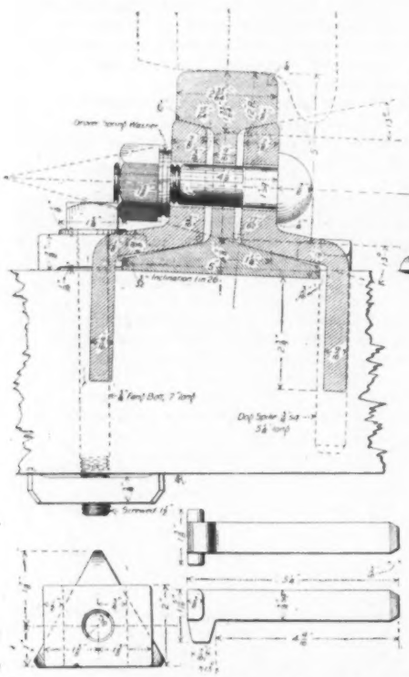


Fig. 1. Standard 80-lb. Rail and Splice Bars, with Fastenings; South Australian Government Railways.

rail. The rail section is shown in Fig. 1, and its dimensions are as follows:

	Ins.
Height	5
Width of base	5
Width of head	2 23/32
Depth of head	1 3/32
Height of web	2 25/32
Depth of flange	7/8
Thickness of web	7/16
Radius of top of head	12
" top corners of head	1/4
" bottom corners of head	1/4
" top fillets	1/4
" bottom fillets	1/4
" top corners of base	1/4
Fishing angles	15°

The rails are either of Bessemer or Siemens steel, and are submitted to drop and dead weight tests. The drop test is made by a weight of 1,456 lbs. falling 10 to 16 ft., the rail being carried on supports 3 ft. apart, resting on a concrete foundation. The rail must stand four blows without breaking. The dead weight test consists of a weight of 44,800 lbs. placed on a rail resting on the same supports. The rail must sustain this for ten minutes without permanent deflection. The holes in the rail are to be drilled, and those in the splice bars punched, and no error exceeding 1-32-in. will be permitted. The rails are made in lengths of 30 ft. In contracts for rails not more than 1% may be 25 ft. long, and not more than 3% may be 27 ft. 6 ins. long. Short rails for use on curves are 29 ft. 6½ ins. long. A contract has recently been awarded in England for 3,500 tons of these rails, with splice bars for same. A description of the arrangements for tests was given in a paper on "English Railway Track," by Mr. E. E. RUSSELL TRATMAN, Transactions Am. Soc. C. E., June, 1888.

The ties are of hard wood, with seats cut out to give each rail an inward inclination of 1 in 26. The strength and hardness of the timber render base plates, or tie plates, unnecessary. The ties are 8 ft. 6 ins. long, 10 ins. wide and 5 ins. deep, and are of blue gum, weighing 65 lbs. per cu. ft.; red gum, 63 lbs.; sugar gum, 63 lbs.; jarrah, 63 lbs.; or karri, 61 lbs. The rails are fastened to the ties by spikes on the inner side of the base, and fang bolts and clamps on the outer side. The bolts, shown in Fig. 1, have square heads, and are screwed down through the triangular fang washers on the under side of the tie, the projections or fangs of the washer biting into the wood and preventing the washer from turning. The rail flange is held by a steel clip or clamp 2×2¾ ins., through which the bolt passes, a round washer ⅜-in. thick being placed between the bolt head and the clamp.

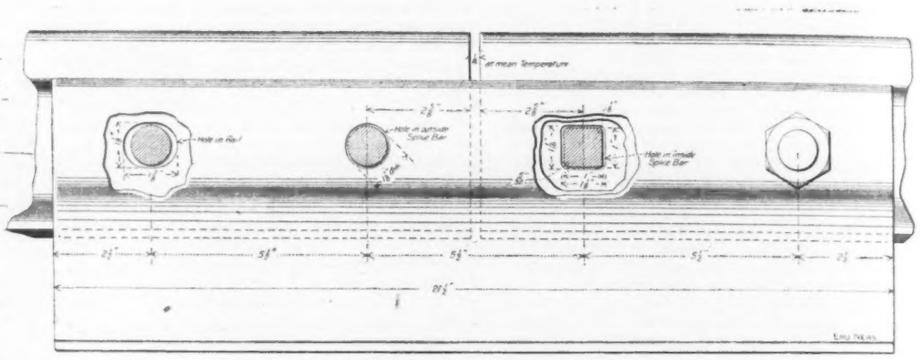


Fig. 2. Elevation of Joint.

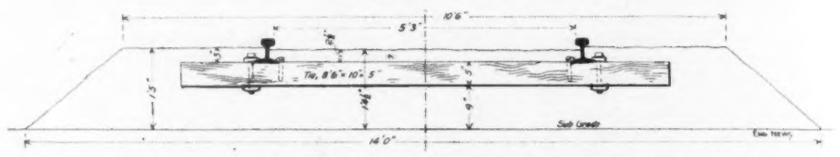


Fig. 3. Cross-Section of Track; South Australian Government Railways.

The bolts are of wrought iron 7 ins. long, ⅝-in. diameter, screwed 1½ ins. The spikes are of steel, 5¼ ins. long, ⅝-in. square, with T-heads. The under side of the head is inclined 13° to fit the upper surface of the rail flange. The ballast is 9 ins. deep under the ties and covers them to a depth of 3 ins. beyond the rails and 2½ ins. between the rails, as shown in the general cross-section, Fig. 3. The ties are spaced 2 ft. 7½ ins. c. to c. at the joints, and intermediate ties 2 ft. 5⅜ ins. c. to c.

The rail joints are suspended, and are spliced by deep splice bars of double angle or Z section, having a vertical web projecting below the base of the rail. The joint ties are laid to but against the ends of the lower webs. The bars are of symmetrical section, and have the upper part of equal thickness from rail head to base. The upper part or web is ⅞-in. thick, and the flange and lower web $\frac{29}{32}$-in. thick. The lower web projects 2⅜ ins. below the bottom of the rail. The bars are 21½ ins. long, and have four bolts; spaced 5½ ins. c to c. The bolt holes in the rail are oval, 1⅛ × 1⅝ ins.; the outer splice bars have holes 1¼ ins. in diameter for the 1-in. bolt; the inner splice bars have rectangular holes 1⅛ × 1⅝ ins., with

TABLE OF QUANTITIES AND WEIGHT OF TRACK MATERIAL.

	No.	Weight.
Steel rails, 80 lbs. per yd.	352	281,599
Steel splice bars, 29.86 lbs. each, 59.72 lbs. per pair	352 pr.	21,021
Grover spring washers	1,408	.....
Steel fish bolts and nuts, 1.794 lbs. per pr.	1,408	2,526
Steel spikes .946 lb. per pr.	4,224	3,996
Wrought iron fang b'lts, 2.249 lbs. per pr.	4,224	9,499
Steel clips 1.067 lbs. per pr.	4,224	4,508
Total	.....	323,149
Ties	2,112	
Ballast cu. yds.	3,116	

rounded corners, fitting a square neck of the bolt 1 × 1 in., also with rounded corners, as shown in Fig. 2. The bolts are 4⅛ ins. long under the head, with button heads, and screwed 1¾ ins. The bolt heads are on the inner side of the rail, and the hexagon nuts and grooved Grover washers or spring nut-locks on the outer side. In laying rails, a space of ¼-in. is left between the ends, at mean temperature.

The quantities and weights of material per mile of single track are given in the accompanying table.

The Siberian Railway.

The Siberian railway commences at Slatiest, Russia's European-Asian frontier, east of Ufa, and extends to Vladivostock, on the Pacific Coast. From Ufa the connection is made westward by existing railways to Samara, Moskow and St. Petersburg. To the east the line passes to Omsk, where the Siberian road proper begins. From Omsk the route proceeds via Rainsk, Ralywan, Marinsk, Atchkinsk, Krasnoiyar, to Kowrsk. Here the railway turns to the southeast and proceeds through Udinsk and Bolangonsk to Irkutsk, 36 miles from Lake Baikal. This lake of 32,000 sq. kilos. area, is surrounded by mountains 6,000 ft. high, and the line is now carried around the south end, instead of ferrying across as originally intended.

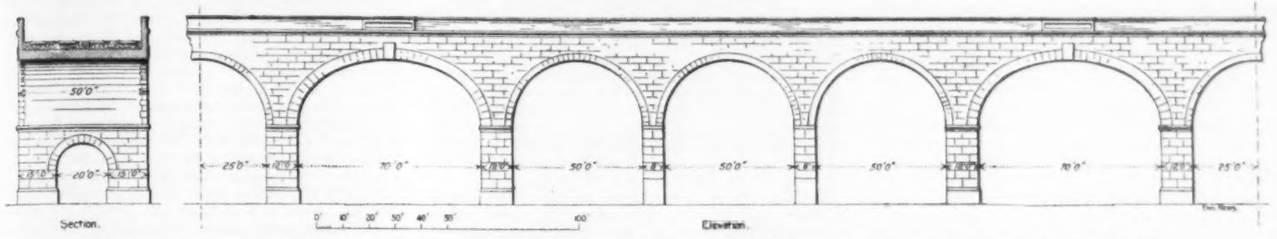
The line then passes to Werchne-Udnisk, where it taps Chinese traffic, and then to Tschita and Nertschinsk. From the latter town of 6,000 inhabitants it proceeds to the navigable river of Shilka, where water transit begins, and passes down this river and the Amur to Nicolajewsk, the old naval port to the entrance of the Amur and opposite the Russian criminal station of Sachalin. The railway will be built later through this region. The length of the railway line from Samara to Nertschinsk is 3,672 miles, and a link of 248 miles of railway is required to connect the terminus at Vladivostock with Usuri, on the Amur. From St. Petersburg to Vladivostock is a distance of 6,200 miles in round numbers.

The road will be built to the usual Russian gage of 1.52 m., or 4 ft. 11¾ ins. The speed proposed is only 13 miles per hour, consequently the trip from Samara to Irkutsk will require about 250 hours; or as the traffic will probably be confined to the daytime, about 16 days. This journey now takes several months. From Irkutsk to Vladivostock there will be about 1,023 miles of railway travel and 1,800 by steamer, or say 14 days more. The estimated cost of the 3,906 miles of railway to be built is 480,000,000 roubles, or say $288,000,000. The first gang of criminal laborers at work on the road now numbers 600.

Proposed Viaducts for the New York City Rapid Transit Line.

We gave last week the most important of the drawings accompanying the report of the New York City Rapid Transit Commission. It will be remembered that for several sections of the line, viaducts are necessary, and for some of these the Commission submitted drawings. The designs, however, show few details of the structures, and the few that are outlined may very likely be departed from in actual construction. We therefore reproduce only one of them, the rather pleasing design for the masonry viaduct which is to run through the blocks on the east side line from Ninety-seventh St. to the Harlem River, a distance of a little less than two miles. The drawing submitted of the Harlem River drawbridge shows no details that are not contained in the report. For the viaduct and approaches across Manhattan Valley on the west side line two sheets of drawings were submitted. The most noticeable features were the adoption of Chief Engineer WORTHEN's proposal to use bowstring trusses for the viaduct as a more æsthetic design than the plain type. The masonry approaches to the viaduct are shown as flat arches supported on massive piers, and with a very inappropriate parapet. Criticism on all these details, however, is out of place until the Commission definitely takes up the preparation of detail plans for the work.

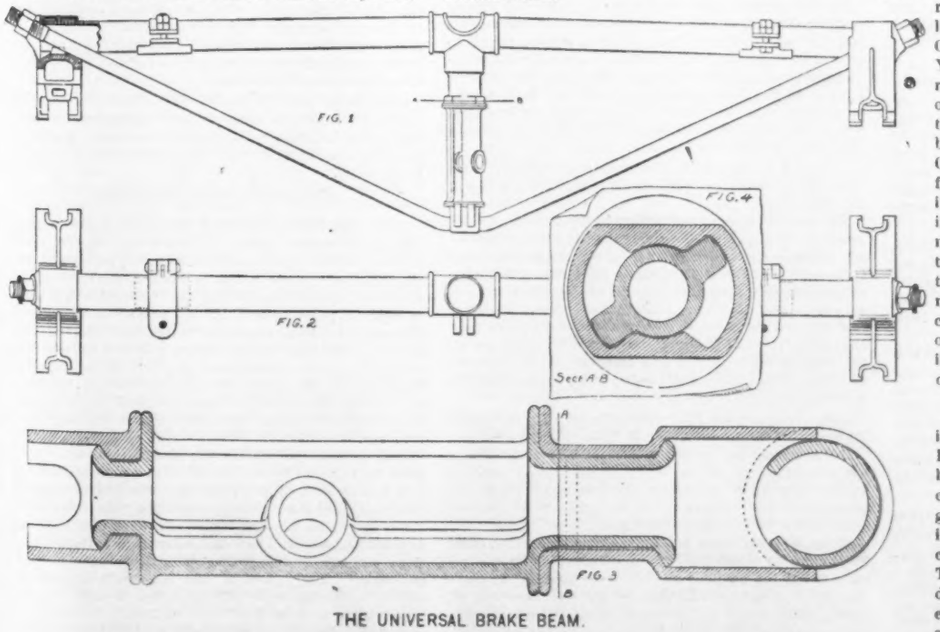
At a meeting of the Board of Aldermen on Wednesday, Oct. 28, the general plan of construction reported by the Commission was unanimously approved. The work of obtaining consents of the property owners along the line will be undertaken at once.



PROPOSED VIADUCT FOR NEW YORK RAPID TRANSIT RAILWAY THROUGH THE BLOCKS EAST OF MADISON AVENUE.

The Universal Brakebeam.

We illustrate herewith a new steel brake beam which has been introduced on several railways and for which several points of superiority are claimed. As seen by the drawings, the beam consists of a tubular main member, trussed against flexure by a strut at the center, over which passes a round steel rod secured by nuts to the two ends of the main member. A longitudinal section of the strut is shown in Fig. 3. It will be seen that this strut is made in three parts, and when the beam is put together the central part of the strut can be turned to lean the brake lever either way, thus making it a right or left hand beam and avoiding the necessity of keeping both right and left hand beams on hand for repairs. The brakehead boxes form abutments for taking the tensile strain of the truss road and transmitting it to the main member. The brakeheads are interchangeable; and any style of brake head desired can be furnished. The nuts on the ends of the truss rods are keyed to prevent slacking.



THE UNIVERSAL BRAKE BEAM.

In tests made by Prof. J. B. JOHNSON, at Washington University, a beam weighing but 46 lbs. withstood a load of 15,000 lbs., with a deflection of but 0.127 in. and without permanent set. The ultimate strength was over 30,000 lbs. Another universal beam of the same weight deflected 0.13 in., with a 15,000-lb. load, and showed no permanent set. The ultimate strength was above 34,000 lbs. The average strength of these beams per pound of weight was 700 lbs. The load per pound of iron on the beam necessary to deflect it .01 in. was 25.1 lbs., as an average of the two beams. The makers claim that the strength of the beam is secured by the use of a high grade of steel as well as by excellent design.

Another point of advantage claimed is that dropping a brakebeam is not so likely to result in derailment with this beam as with the ordinary wooden beam. While the beam is stronger and far stiffer than a wooden beam, the thin steel plates, of which it is composed, will be rolled flat if struck by a car wheel and may be passed over without derailment.

The weight of the beam complete with brakeheads is but 75 lbs., or about half of that of the old wooden beams.

According to the report of the Master Car Builders' Association Committee on Air Brake Standards to the Cape May Convention (see ENG. NEWS, June 13, 1891), a very large proportion of the air brake cars in service are now equipped with metal brakebeams. The replies to the committee's circular also showed that the leading railway managers are strong in the opinion that good results in air braking cannot be secured with wooden brakebeams; and they were nearly unanimous in declaring that a metal beam is necessary to secure the best results.

A TORPEDO-BOAT DEFENSE BOOM was tested lately by the British Admiralty officials in Portsmouth harbor. This boom was thickly studded with sharp steel spikes and had a 7-in. steel hawser stretched above it to prevent attacking boats from riding over the boom. A swift torpedo boat was used with a massive framework extending from bow to stern intended to lift the hawser. The boom was adjusted across the mouth of the harbor and was struck by the boat at a 19-knot rate of speed. The boat nearly cleared the boom but was caught by the hawser and pressed against the spikes, and these tore her bottom so badly that she sank.

A STEEL CANTILEVER BRIDGE will be built by the city of Albany, Ore., across the Willamette river at that place. The total length will be about 2,000 ft., consisting of pile trestle approach, with a cantilever truss containing a centre span of 400 ft. and shore arms of 300 ft. each, followed by a single clear span of 300 ft. The width of the roadway will be 20 ft. in the clear, with a sidewalk 4½ ft. wide. The substructure will consist of steel shells filled with concrete and resting on pile foundations. The bridge will afford a clear headway over the river of 32 ft. at extreme high water. The King Iron Bridge & Mfg. Co., of Cleveland, O., has the contract.

THE COMMITTEE ON SAFETY APPLIANCES appointed at the last annual convention of Railroad Commissioners, will give a public hearing, Nov. 10, at the Chamber of Commerce rooms, 34 Nassau St., New York, on the subject of federal regulation of railway safety appliances. All organizations of railway employees or officials are invited to be represented at it, but we are requested by the Secretary of the Interstate Commerce Commission to call especial attention to the fact, in connection with this meeting, that it "will be confined strictly to those who are in the employ of railway companies, and is not for those who are interested in any particular coupler. The limited time allowed the committee is insufficient to enter into the merits of the hundreds of different types of couplers, and the meeting is for the purpose only of hearing the views of those directly interested in regard to the federal regulation of safety appliances."

A FOUR-CYLINDER COMPOUND LOCOMOTIVE is to be built at the Philadelphia shops of the Philadelphia & Reading R. R. after designs by Mr. JACKSON RICHARDS, Master Mechanic in charge of these shops. The engine is to have two high-pressure cylinders inside the frames, and two low-pressure cylinders outside in the ordinary position. The cranks for the outside and inside cylinders are to be set at an angle of 180° from each other, and will be of equal weights, so that the engine will be perfectly balanced at all speeds, and no counterbalance weights will be needed. The locomotive will be equipped with the Wooten firebox, and is expected by Mr. RICHARDS to make a record for fast running.

PERSONALS.

Mr. D. S. HILL, General Superintendent of the Lake Erie & Western R. R., has resigned, and Mr. GEO. T. JARVIS has been appointed in his place.

Mr. WILLIAM D. EWING has been appointed Assistant General Superintendent of the Fitchburgh R. R., in charge of the operating department, with office at Boston, Mass.

Mr. CLEM HACKNEY, formerly Superintendent of Motive Power of the Union Pacific Ry., has been appointed General Manager of the Fox Solid Pressed Steel Co., vice Mr. F. P. DAVIDSON, resigned.

Mr. J. MADISON PORTER, formerly with Tippett & Wood, has been elected Professor of Civil Engineering in Lafayette College, Easton, Pa. He has been assisting in instruction at the college since the death of Prof. Fox.

Mr. C. H. ROCKWELL, General Superintendent of the Columbus, Hocking Valley & Toledo Ry., has been appointed General Superintendent of the Chicago & Eastern Illinois R. R. and Chicago & Indiana Coal Ry., with headquarters at Chicago, Ill.

Col. PETER C. HAINS, U. S. Engineer, and for a long time in charge of the reclamation of the Potomac flats, in Washington, and other engineering works in Maryland and Virginia, has been ordered to the Department of Dakota, with headquarters at St. Paul.

Mr. LAWRENCE G. GRAHAM, railway contractor, of Whitewater, Wis., died in Milwaukee, Wis., Oct. 18. He built the Milwaukee & Mississippi road, the first line constructed in Wisconsin, and now a part of the Chicago, Milwaukee & St. Paul R. R., and helped to build many of the early railways in Minnesota and Dakota.

Mr. WM. J. GALWEY, M. Inst. C. E., was killed in Siam recently in a boat accident on the Mehnam River. He was chief of an engineer corps surveying for the projected railway from Bangkok to Chiengsin, on the Chinese frontier. He had been in Siam for two years, after several years' service in India, and was 60 years of age.

Mr. WILLIAM HASSMAN, who recently resigned his position as Master Mechanic of the Cincinnati and Huntington divisions of the Chesapeake & Ohio Ry., has been appointed Superintendent of Motive Power of the Western division of the Newport News & Mississippi Valley R. R., vice Mr. J. W. LUTTRELL, resigned.

Mr. ANGUS SINCLAIR, long and favorably known as an authority on locomotive practice, Secretary of the American Railway Master Mechanics' Association, and editor of the *National Car and Locomotive Builder*, has joined with Mr. JOHN A. HILL in purchasing *Locomotive Engineering*, which will hereafter be conducted under their joint management, with offices at 912 Temple Court, New York. We have no doubt that that journal will become under their management one of even better standing than heretofore.

NEW PUBLICATIONS.

—*Notes on Rankine's Civil Engineering.* Part II. For the Use of Engineering Students of the University of Michigan. By CHARLES E. GREENE, Ann Arbor, Mich., 1891. Price $1.

This work of 124 pp. is a lithograph facsimile of manuscript, in the form of notes intended to explain away the difficulties which the average student finds in the works of Mr. Rankine. Professor Greene has, in fact, here set down what he usually explains orally to his classes or puts on the blackboard, and has added some new material that he has found useful in past years. A full index adds to its value, and its usefulness will doubtless extend beyond the class room.

—*A Course of Instruction in Ordnance and Gunnery*, for U. S. Military Academy. By Capt. HENRY METCALFE, Ordnance Dept. U. S. Army, Instructor in Ordnance and Gunnery, U. S. Military Academy. New York, 1891. John Wiley & Sons. Second edition. One volume in text, 8vo, and a folio volume of illustrations.

The rapid advances in our knowledge of the properties of gunpowder and in improvements in metallurgy, together with the great variety of new arms introduced within a very few years, renders obsolete works on ordnance and gunnery published as late as a decade or two ago. The present work of Captain METCALFE deals with these advanced methods; and his treatment of the subject shows in a marked degree what these advances, or rather this revolution in arms and powders, really means.

—*Bulletin de la Commission Internationale du Congrès des Chemins de Fer*, Brussels, Belgium. Vol. V., Nos. 7, 8, 9; July, August and September. Paper, 9½ × 7 ins., pp. 132. Illustrated.

This number contains the following papers: "The Production of Steam," E. SAUVAGE; "Steam Traction on Secondary Railways," L. AMORETTI; "Locomotive Boilers," M. BELLEROCHE; "Rolling Stock for Railways with Light Traffic," S. ABELES.

—*Annual Report of the State Engineer and Surveyor*, New York. JOHN BOGART, State Engineer. 8vo, pp. 456, numerous plates.

This report is unusually elaborate and complete, containing an unusual proportion of other than routine matter. Among other subjects very fully treated are the supply of water to the Erie Canal from the Genesee River, and the condition of the boundary monuments of the state, which is in general very bad on the north and east of the state, and good upon the south only. The matter of most general interest, however, is the careful tabulation of the rate of recession of Niagara Falls, as determined by a survey made last year. The results of the survey, which we long ago published, were that recession was going on at a very rapid rate; but the details given in this report are of much interest. Four different surveys were compared, those of 1842, 1875, 1886 and 1890, all which exist of much accuracy and the *mean* annual recession, as deduced by dividing the total area receded by the mean length of the crest line, has been as follows:

	American Falls.			Horseshoe Falls		
	1875.	1886.	1890.	1875.	1886.	1890.
1842 to.....	0.74	0.59	0.64	2.01	1.91	2.18
1875 to.....	...	0.11	0.51	...	1.86	2.74
1886 to.....	...	...	1.65	...	...	5.01

The total mean recession in feet for the entire crest line in the 48 years since 1842 is 30.75 ft. for the American fall and 104.51 ft. for the Horseshoe fall; the maximum recession of the latter at any one point having been not less than 270 ft. since 1842, 180 ft. since 1875 and 80 ft. since 1886, or in only four years. The indications seem to be that the rate of recession is tending to increase.

We have extracted for publication elsewhere the rules and results of the cement tests given in this report, which is in every way a creditable one. If our politicians could only once reconcile themselves to the principle of letting a good officer alone, in technical positions at least, we might have more such reports which are worth serious attention.

—*Annual Report of the State Board of Health of Indiana for* 1890. C. F. GRIFFIN, Secretary. Cloth, 6 × 9 ins.; pp. 272.

This report contains little of engineering interest except a reprint of Mr. W. P. GERHARD'S "The Disposal of Household Wastes."

—*Report of the Water Commissioners, Yonkers, N. Y.*, Dec., 1890. J. A. LOCKWOOD, Clerk and Superintendent. Pamph., pp. 32.

This report contains two interesting tables showing for the years 1877 to 1890, inclusive, the amount of water pumped, the amount metered at different rates, the total cost and cost per cubic foot to pump water, pump and distribute it, pump, distribute it and pay interest on bonds. The receipts are given in similar detail.

—*Report of the Newark, (N. J.) Aqueduct Board for* 1890. A. P. SMITH, Supervisor. Pamph., pp. 104.

A table in this report shows the day and night consumption for both the high and low service, and for both, for each day of the year. The day is divided at 7 o'clock, morning and evening.

—*Annual Report of the Board of Public Works (Milwaukee) for* 1890. G. H. BENZENBERG, City Engineer. Pamph., pp. 266 and many folding sheets of tables; illustrated.

Those interested in the cost of sewers will find figures in this report of cost, by sizes, of sewers built during 1890, but will be obliged to calculate the cost per foot for themselves. A diagram shows graphically the daily consumption per week in 1889 and 1890. A photogravure presents a view of the Milwaukee River masonry dam, nearly completed. The pump at the river flushing works lifted, during the year, 100,989,000,000 galls. of lake water into the Milwaukee River.

—*Annual Reports of the Department of Public Works, New Haven, Conn., for* 1890. A. B. HILL, City Engineer. Pamph., pp. 48.

The cost of sewer construction in 1890 is shown in this report by means of a table giving length, size and material, average cut and character of excavation, and contract price per foot for all sections of sewers built. Another table shows the prices named by the several bidders on each piece of work. The average contract price per foot for sewers built in 1890 is as follows, the last four sizes being vitrified pipe and the first five being brick, the 30 and 24-in. having 8-in inverts: 48-in., $7.00; 42 and 36-in., $6.00; 30-in., $4.25; 24-in., $3.18; 18-in., $1.83; 15-in., $1.49; 12-in., $1.20; 9-in., 80 cts.

—*The Newport (R. I.) Water-Works. Its Excessive Charges and the Remedy.* By X. Y. Z. Pamph., pp. 26.

This pamphlet is a reprint of a series of nine letters to the Newport *News*, all but seven of which were inserted as advertisements, presumably because space would not be given to them otherwise. The writer shows by figures, partly taken from the *Manual of American Water-Works*, that the Newport rates are higher, comparatively, than those charged in other cities. He thinks the city has the right to buy the works at a price to be fixed by arbitration, and if it has not then that the General Assembly of Rhode Island should be induced to regulate the company's rates. As the matter is of a local character the interested reader is referred to the pamphlet for further particulars. It is interesting to note, however, that X. Y. Z., since the publication of the letters, has been elected Mayor of Newport on a water-works reform ticket, and that the same election put a majority of the city government on his side, all the reform aldermanic candidates having been elected.

—*Annual Report of the Provincial Board of Health of Ontario for* 1890. P. H. BRYCE, Toronto, Secretary. Pamph. pp. cx + 150.

The report of the Secretary discusses among other things, the "Economics of Public Health Work," "Sewage Disposal" and "Public Water Supplies." Illustrations are given showing different appliances for the removal of household wastes. There are some reports on special subjects, as one on "Sanitary Progress in Great Britain," by Mr. C. W. COVERNTON and another, the "Conder System of Treating Sewage at the Ontario Institute for the Deaf and Dumb, Belleville," by the Secretary and Mr. R. CHRISTIE, Inspector. Annual reports of local health boards occupy more than half of the volume.

—*Report of the Executive Board, Rochester, N. Y.*, 1891. EMIL KUICHLING, Chief Engineer Water-Works. Pamph., pp. 223.

This pamphlet contains the several reports of the Chief Engineer of the Water-Works, City Surveyor, Chief Engineer of the Fire Department, Superintendent Fire Alarm Telegraph and Superintendent of Streets. The original and present discharging capacity of the water supply conduit from Hemlock Lake is discussed by Chief Engineer KUICHLING. The diminution in daily carrying capacity is stated as about 2,000,000 galls., or from 9,000,000 to 7,000,000 galls. The cause of the decrease is not known, but it is supposed to be mainly a deterioration of the inner surface of the conduit, either by the growth of spongilla or other organisms, by rust, or by both. The conduit is of 36-in. wrought iron pipe for 9.6 miles, then 24-in. wrought iron for 3 miles, then 24-in. cast iron for 6.8 miles, a total length of nearly 20 miles. The subjects of temporary and permanent additional supplies are discussed by Mr. KUICHLING at some length, and the latter is also discussed by a Committee on Additional Supply and by Mr. A. FTELEY.

The report contains a plumber's table showing the streets in which domestic water mains are laid, together with size of mains, width of street, side of street upon which pipe is located and distance of pipe from curb or other fixed line. This table must be of great local service.

TRADE PUBLICATIONS.

—*Utica Hydraulic Cement.*—Utica Hydraulic Cement Co., Utica, Ill. Paper, 5 × 7¼ ins., pp. 61.

This pamphlet contains a treatise on American natural hydraulic cement, the report of the Am. Soc. C. E. committee on a uniform system of testing cement, and particulars in regard to sand, concrete, masonry, grout, etc., and 8 pages of testimonials.

Catalogue of the Heine Safety Boiler Co.—New York office, 45 Broadway.—A well illustrated descriptive pamphlet showing in detail the peculiar features of this boiler and its setting. Mr. E. D. MEIR, C. E., in a paper read before the Am. Inst. of Mining Engineers, says that the first Heine boiler, built in Berlin in 1879, has continued in uninterrupted service since under 150 lbs. working pressure without repairs of any kind. It is a gravity-return water-tube boiler, with the main body of water at the rear end of the shell. The advantages claimed are economy in space and fuel, safety at high pressure, perfect accessibility of interior and the prevention of scaling. This type of boiler has been adopted for the power plant of the Broadway Cable Ry.

—*The Slide-Rule Perpetual Calendar.*—A convenient pocket calendar for all time, with full directions for use—indicating the days of the week for any year, past or to come. Jerome Thomas Co., 47 Lafayette Place, New York. Price, 25 cts.

SOCIETY PROCEEDINGS.

American Street Railway Association.—The tenth annual convention was held at Pittsburg, Pa., Oct. 21, 22 and 23. A large number of members were present. After the calling of the roll by Mr. William J. Richardson, the Secretary, an address was read by the President, Mr. H. M. Watson, of Buffalo, N. Y. He referred especially to the wonderful development of electric railways, the capital invested in which he estimated at $75,000,00), and also presented the statistics given in our issue of Oct. 10. Referring to the paper to be read by Mr. H. G. Scribner on "Public Treatment of Corporations," he said that those who have pooled their property, in the belief that they can work better together than each with his individual capital, feel keenly the abuse from those who seem to have no conception of what a corporation is or why it is formed. The government has established mail routes on some street railway lines, the plan being to fit the cars with mail boxes, which are taken up and sorted at some central point, and city letters sent to the sub-stations without the delay of sending them to the general post-office. The report of the Executive Committee showed a membership of 180 companies. It also referred approvingly to employees' mutual benefit associations, and stated that managers would do well to hasten the coming of the day when employés will have vested interests in the business of the companies.

The first paper presented was by Mr. H. A. Everett, upon "A Perfect Electric Motor," the general conclusions of which, with discussion thereon, we shall give

later. The writer referred to the early history and development of the electric motor, and stated that he expects within a few years, as the motors are perfected and their armature speed reduced, to see a line of railway from New York to Chicago run on a 2-hour time table for the through trip, and giving a transportation rate considered impossible with the present motive power. From experience in operating cars from 16 to 30 ft. in length he was of opinion that on routes having a small patronage where the earnings are under 20 cts. per car mile run, it is unwise and undesirable to have a car exceeding 21 ft. in length inside, as it is more economical to have trail cars when the traffic is heavy than to be at the continuous daily expense of hauling a large car of great weight.

At the evening session a long paper on "The Progress of Cable Motive Power," by Mr. J. C. Robinson, was read, and of this we shall give an abstract later. The paper stated that a road carrying 2,000 passengers daily could be profitably converted into a cable line. The next paper was by Mr. G. W. Mansfield, of Boston, Mass., on "The Dependent (Overhead and Underground) System of Electric Motive Power," an abstract of which, with the discussion, is given elsewhere. The author considered the overhead wire system to be the only one yet practicable, although he recognized the advantages of other systems.

At the meeting on Oct. 22, a paper by Mr. G. Hilton Scribner on "Public and State Treatment of Corporate Property," was read by Mr. C. D. Wyman, in the absence of the author. The paper was a defense of corporations, and a denunciation of the injustice of legislation taxing corporate bodies. The author said that the only thing on which the Republican and Democratic parties of the state of New York ever agreed was in claiming the credit of perpetuating the gross injustice of oppressing corporations. He explained the alleged oppressive legislation in New York in relation to corporations, and Mr. Wyman supplemented it by a statement of how corporations are taxed on the real estate covered by their tracks, as if they owned the ground. Mr. Wm. M. Stephenson, President of the Columbia Ry. Co., of Washington, D. C., commended the paper, but said the state treatment of corporate property was very lenient compared with the National treatment of companies in the District of Columbia. His company had paved the streets and paid the bills when the city changed the grades, and was required to again pay for the paving; this was contested and the case carried to the U. S. Supreme Court, which decided against the corporations, ordering them to pay the bills, amounting to $231,000, within 10 months or forfeit their franchises. Mr. H. C. Pain, President of the Milwaukee Street Ry. Co., said matters are not so bad in the West as most of the new states have a provision in their state constitutions requiring a uniformity of taxation.

A paper on "The Independent (Storage or Primary Battery) System of Electric Motive Power" was then presented by Mr. Knight Neftel, of Lancaster, Pa. He stated that the use of storage batteries had been accomplished with a varying amount of success. The batteries have been in use long enough on various roads to justify the prediction that good results are practicable in the near future. Of this paper we give an abstract elsewhere.

Mr. G. W. Baumhoff, of the Lindell Ry. Co., St. Louis, stated that he has tried the storage battery with varying scientific success, but not with any commercial success. He tried it for at least 18 months on a road where the grade is not over 2½%, and found that it might be a success if the capital of the company would hold out. The company is satisfied it cannot afford to operate them. Mr. Wharton, of Detroit, said that they found that it requires just as long to change a battery as to discharge it. His experience was that they are not a commercial success. Mr. Scott, of Philadelphia, spoke of two roads, one in Washington and one in Dubuque, that are being operated successfully with storage batteries with profit. Mr. Montague, of Yonkers, mentioned a system of storage batteries which, he said, is certainly successful. One car will take 85 passengers and climb a 10% grade with ease and no injury to the battery. Three cars have run 42, 46 and 48 miles without a change of battery or recharging.

At the afternoon session a paper on "Standards in Electric Railway Practice" was read by Mr. O. T. Crosby, in which he advocated a system of standard descriptions for motors, defining their horizontal effort at a given speed and their efficiency percentage. He also suggested standards for poles, trolleys, gearing, truck details, and a uniform system of accounts, and presented a proposed list of nomenclature to avoid the present use of different terms for the same object.

At the conclusion of his report, Mr. Crosby made a motion that a committee on standardizing of ratings, nomenclature, dimensions and accounts for electric street railways be appointed by the association. This was seconded by Mr. Macfarren, of Pittsburg, who said that he had long felt the necessity for some uniformity in this respect, and that it is time that the association took such a step, so as to keep in rank with similar societies which have all adopted methods of this character. He thought that no matter of business has ever been taken up by the association which will be productive of such good results as this matter. The motion was adopted, the committee to consist of seven members, including the president and secretary.

The annual banquet was given in the evening.

The following officers were elected for the ensuing year: President, John G. Holmes, Pittsburg, Pa.; First Vice-President, Thomas H. McLean, New York, N. Y.; Second Vice-President, James B. Speed, Louisville, Ky.; Third Vice-President, Albion E. Lang, Toledo, O.; Secretary and Treasurer, Wm. J. Richardson, Brooklyn, N. Y. Executive Committee: Henry M. Watson, Buffalo, N. Y.; Lewis Perrine, Jr., Trenton, N. J.; W. Worth Beam, St. Joseph, Mich.; Murry A. Verner, Pittsburg, Pa.; Thomas C. Pennington, Chicago, Ill.

The meeting was well attended and very successful. The next meeting will be held at Cleveland, O.

EXHIBITS.

The exhibits at the meeting exceeded any similar display given under the auspices of the association. A double-decked barge and a river steamboat were moored at the wharf adjacent to the Monongahela House and were used for exhibition purposes. Along the street at the side of the hotel were some full sized cars, showing all the recent improvements, also some snow sweepers, plows, &c. In the hotel every available corner was used for displays, while a large number of rooms were devoted exclusively thereto. On the barge were full sized car trucks, motors, and appliances of every description. Every conceivable part of the business was shown in full detail. Nearly all the leading dealers and inventors in appliances for electric and cable cars were represented, and all the large electrical equipment companies had agents on the ground. Space will not permit any extended mention of the exhibitors or the character of the goods shown, but the following is a partial list:

Thomson Houston Electric Co., of New York. Material for overhead wire equipment; motors; switch board, rheostats and instruments.

Westinghouse Electric & Mfg. Co., of Pittsburg, Pa. Several electric motors and trucks, including a motor in a water-tight casing, and a gearless motor.

Short Electric Railway Co., of Cleveland, O. Trolley materials and fittings; switch board and instruments; gearless and single reduction motors.

Edison General Electric Co., of New York, N. Y. Motor truck, switches and other appliances; lamps, transfer table, dynamo.

Solar Carbon & Mfg. Co., of Pittsburg, Pa. Carbons and motor brushes.

Wightman Electric Mfg. Co., of Scranton, Pa. Wightman motor and trolley.

Engineering Equipment Co., of Boston, Mass. Insulators and line material.

Standard Underground Cable Co., Pittsburg, Pa. Cables and wire of various kinds.

Electrical Construction & Supply Co., of New York, N. Y. Ward arc lamp.

John White, of Allegheny, Pa. Insulators of hard wood, saturated with a patent insulating solution.

Western Electric Co., of Chicago, Ill. Railway supplies.

Eastern Electrical Supply Co., of Boston, Mass. Railway specialties and overhead wire appliances. Portable switches.

Electrical Merchandise Co., of Chicago, Ill. Insulators, track brooms, rawhide pinions, electric headlights.

Burton Electric Co., of Richmond, Va. Electric heaters.

Alexander, Barney & Chapin, of New York, N. Y. Electric lights and railway supplies and White's chairs for girder rails.

McConway & Torley, of Pittsburg, Pa. Rail joints.

Peckham Motor & Truck & Wheel Co., of Kingston, N. Y. Radial geared cantilever truck; dust proof, self-oiling boxes.

A. Whitney & Sons, of Philadelphia, Pa. Chilled car wheels and the Whitney contracting chill.

Pennsylvania Steel Co., of Steelton, Pa. Girder rails frogs, etc.

Johnson Co., of Johnstown, Pa. Girder rails, slat rails and other track material.

Brooklyn Railway Supply Co., of Brooklyn, N. Y. A, "Walkaway" snow plow for horse power.

Walker Mfg. Co., of Cleveland, O. Differential cable drums.

Bryant & Barbey, of Boston, Mass. Portable rail saws.

Hale & Kilburn Mfg. Co., of Philadelphia, Pa. Car seats.

New York Car Wheel Works, of Buffalo, N. Y. Machined car wheels.

Pomeroy & Fisher, of New York, N. Y. Colors and varnishes.

Rochester Car Wheel Works, of Rochester, N. Y. Car wheels, and a Barr contracting chill.

J. G. Brill Co., of Philadelphia, Pa. Car trucks, including a special truck (No. 13) for long cars on uneven tracks. It has an extended spring base, and elliptical springs at the corners to reduce the oscillation and lurching at crossings, low joints, etc. Also a car.

Lewis & Fowler Girder Rail Co., of Brooklyn, N. Y. Rails, switch, frog, chairs, joints, and fare registers.

Lewis & Fowler Mfg. Co., of Brooklyn, N. Y. Snow sweeper for electric railways. Car specialties.

Reliance Gauge Co., of Cleveland, O. Safety water columns and steam appliances.

Jewell Belting Co., of Hartford, Conn. Belt 48-in. wide and 110 ft. long.

Tripp Mfg. Co., of Boston, Mass. Roller bearings for cars; piston packing.

Robinson Machine Co., of Bellwood, Pa. Electric motor truck.

Baltimore Car Wheel Co., of Baltimore, Md. Motor truck with new spring and brake arrangements.

Charles Munson Belting Co., Chicago, Ill. Machine belts.

Morton Safety Heating Co., of Baltimore, Md. Car heating by means of heat stored in earthenware tubes inclosed in iron tubes, placed under the seats. By the application of steam for 5 minutes in the morning before the car leaves the stable or power-house, sufficient heat is said to be stored to keep the car comfortable for several hours, and it is not necessary to change it for more than 2 or 3 minutes every 3 or 4 hours.

Brownell Car Co., of St. Louis, Mo. "Accelerator" car, with door at one side of platform instead of at middle.

Leib Machine Works, of New York, N. Y. Street railway supplies and appliances.

Bodifield Belting Co., of Cleveland, O. Machine belting.

Schneider Combination Car Co., of Chicago, Ill. Combination car for summer and winter service.

Calorific Ventilating Co., of Chicago, Ill. Car heating and ventilating appliances.

Pierce Bros. & Co., of Leominster, Mass. Portable track drill and emery drill sharpener. Overhead wire appliances.

American Society of Mechanical Engineers.—The annual meeting will be held in New York at the society's house, Nov. 16 to 20, inclusive. The opening session will be at 8:30 P. M., Monday, Nov. 16, followed by a social reunion. On the 17th there will be a session of society business, action on amendments to the rules, reports of committees, etc.; excursions in the afternoon and a session for papers in the evening. On the 18th there will be an excursion to the Brooklyn navy yard and the shops of the De La Vergne Refrigerating Co., with a theater party in the evening. Tickets for the American Institute Fair will also be provided. On the 19th there will be a morning session for papers and discussion, excursions in groups in the afternoon, and a public reception at the Lenox Lyceum in the evening. On the 20th there will be a concluding session for the presentation of papers. The list of excursions will be announced at the meeting. The following is a list of the papers: "Experiments to Determine the Rate of Rise or Fall of a Mercurial Thermometer Under Different Conditions," "Test of Indiana Block Coal at the Chicago West Side Pumping Station," and "Limitations of Steam Engine Economy," A. F. Nagle; "The Value of Water Power," Chas. T. Main; "The Brooklyn Pumping Engine of 1860," Samuel McElroy; "The Idiosyncrasies of Chimney Draft," W. E. Crane; "Electric Power Distribution," H. C. Spaulding; "Influence of the Steam Jackets of the Pawtucket Pumping Engine," Wm. Kent; "A Combination Iron and Oak Pavement," J. Wendell Cole; "Test of a Pulsometer," De Volson Wood.

American Gas Light Association.—The nineteenth annual convention was held in New York City, Oct. 21 and 22. Fifty-two new members were added to the association. The following officers were elected: President, Wm. Henry White; Vice-Presidents, O. E. Boardman Wm. H. Pearsons, Walton Clark; Secretary and Treasurer, A. B. Slater, Jr., Providence, R. I. Among the papers presented were the following: "Leakage," by Chas. H. Nettleton; "Meter Rents," by Walton Clark; "The Illuminating Power of a Mixture of Coal and Water Gases," by Dr. E. G. Love; "Intensity of Light," by A. B. Slater, Jr., and "Theoretical Effect of Pre-Heating Blast, Steam and Oil in Water Gas Manufacture," by Rollin Norris. A committee of seven was appointed to secure an adequate representation of gas lighting and heating industries at the World's Columbian Exposition. The next annual convention will be held in Boston.

American Association of Irrigation Engineers.—An association with the above name was recently organized at Salt Lake City, and has elected the following officers: President, A. D. Foote, Boise City, Ida.; Vice-President, G. G. Anderson, Denver; Secretary and Treasurer, C. L. Stevenson, Salt Lake City. The directors are: L. G. Carpenter, Ft. Collins, Col.; H. I. Willey, San Francisco; J. B. Greene, Denver. The headquarters for 1891-2 will be at Salt Lake City. Each member is required to furnish three months before the annual meeting an essay of 1,000 words on irrigation or pay a fine of $10.

State Association of Irrigation Districts of California.—The annual meeting of the association was held at Los Angeles, Oct. 20 and 21. Delegates were present from at least 16 districts. J. W. Nance, of Perris, was re-elected President and A. J. Pillsbury was re-elected Secretary. Reports were presented showing the progress made in several districts, and a considerable amount of time was spent in discussing the marketing of district bonds.

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AND

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GEO. H. FROST..... .....BUSINESS MANAGER

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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Civil Engineers' Society of St. Paul.—Nov. 2. Secy., C. L. Annan.
Engineers' Club of Kansas City.—Nov. 2. Rooms, Baird Building. Secy., H. Goldmark.
Boston Society of Civil Engineers.—Nov. 4. Secy., S. E. Tinkham, City Hall.
Western Society of Engineers.—Nov. 4. Secy., J. W. Weston, 280 La Salle St., Chicago.
Engineers' Club of St. Louis.—Nov. 4. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
American Society of Civil Engineers.—Nov. 4. "Water Supply and Water Waste Prevention at Rochester, N. Y." Secy., Francis Collingwood, 127 East 23d St., New York.
Engineers' Club of Minneapolis.—Nov. 5. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Association of Civil Engineers of Dallas.—Nov. 6. Secy., E. K. Smoot, 803 Commerce St.
Technical Society of the Pacific Coast.—Nov. 6. Secy., O. von Geldern, 819 Market St., San Francisco.
Swedish Engineers' Club.—Nov. 7. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
Northwest Railroad Club.—Nov. 7. Rooms, Union Station, St. Paul.
Atlanta Society of Civil Engineers.—Nov. 10. Secy., Parker N. Black, Room 39, Capitol Block.
Denver Society of Civil Engineers.—Nov. 10. Secy., Geo. H. Angell.
Northwestern Society of Engineers.—Nov. 10. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Nov. 11. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—Next meeting, Nov. 11. At United States Hotel, Boston. Secy., F. M. Curtis.
Civil Engineers' Club of Cleveland.—Nov. 13. Secy., A. H. Porter, 50 Euclid Ave.
Engineering Association of the Southwest.—Nov. 13. Secy., O. H. Landreth, Nashville, Tenn.
Northwestern Track and Bridge Association.—Nov. 13. Rooms, Union Station, St. Paul.
American Society of Mechanical Engineers—Annual meeting in New York; Nov. 16 to 20. Secy., T. R. Hutton, 121 W. 31st St.
Western Railway Club.—Nov. 17. Rooms, Rookery Building, Chicago.
Engineers' Society of Western Pennsylvania.—Nov. 17. Secy., J. H. Harlow, Pittsburg, Pa.
Engineers' Club of Cincinnati.—Nov. 19. Secy., J. F. Wilson.
New York Railroad Club.—Nov. 19. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Nov. 19. Secy., T. G. Philfeldt, 118 Adams St.
Montana Society of Civil Engineers.—Nov. 21. Helena.

SOMEWHAT of an era-making decision appears to have been reached by the Board of Education in Philadelphia, to put elevators in the new normal school building for the use of the girl pupils. The matter is not yet decided, but the majority of the committee of the board in charge of the building favor it, and it appears to be expected that the elevators will go in. If so, it will be the first school building in the world to be so provided, we apprehend, but we may be tolerably sure it will not be the last. The building in question, is, we believe, only four stories high, but there are others higher and still others likely to be built which it will be desirable to carry higher. The pupils in this school have a good deal of running up and down stairs to do from classroom to classroom, besides that involved in entering and leaving the building, and it is not unreasonably claimed that the small cost will be very much more than repaid in the saving of the time and strength of the pupils, besides saving the occasional instances of serious injury to health from running up and down stairs. Had the pupils the same voice in the matter as adults have we may be quite sure that elevators would have gone into many school buildings before now, as they have gone into nearly all office buildings of over three stories in height. The fashion once set will be likely to extend rapidly, as it is founded on reason and good sense.

A CORRESPONDENT of *Engineering* takes a dismal view of the possible utility of our new naval vessel, which is officially known as a "commerce destroyer," and popularly known as "The Pirate." He remarks that she may do very well "as a scarecrow, but it remains to be seen if she is so far ahead of European ships as to justify Mr. Secretary TRACY'S spread eagleism," and thus expresses his grounds for doubt:

> The pirate of the eighteenth century, after capturing and plundering a merchant ship, relieved himself of further trouble by sending her with all hands to the bottom. I presume it is not intended that the captain of a ship flying the stars and stripes should, after capturing a mail steamer, send her to the bottom with her living freight. How, then, is he to manage? He must either (1) take the crew and passengers on board his own ship as a preliminary to destroying the captured one, which would soon crowd him like an excursion steamer; or (2) convoy her to his nearest home port, which involves great delay; or (3) put a prize crew aboard, which means carrying several *spare* prize crews; or (4) take what valuables and stores he requires out of her and let her go, which would hardly be worth the time and trouble. There appears to me no other course, as to cripple the captured ship and then let her go would be too cowardly a proceeding to ask a sailor to share.

Had this doubting Thomas left the pirates of the 18th century alone, and bethought himself of the history of a vessel of his own time, built and manned in England, and also popularly known (on this side of the water) as "The Pirate," he would have seen how easy it is to overcome his little difficulty, by a judicious combination of his four alternatives, as follows: Use alternative (1) for the first three or four ships, until the crowd of captives becomes inconvenient, taking care in every case to burn and not to scuttle the captured ships, in order that they may serve as decoys for further victims. Then resort to alternative (4) loading the ship with all the captives on hand, resorting to alternative (2) or (3) only when it is convenient or specially desirable. In this way, very recent history proves that even a single slow ship can keep the sea against many pursuers for months or years, and do infinite damage to a comparatively small merchant marine. How much more damage then could four or five such vessels do if the fastest in the world and acting together? We earnestly hope there may never be an answer to this conundrum; but there is much less likely to be if the necessary vessels are available, and it is rather surprising to see the possibility of it so soon forgotten in the country which served as the base of the first effort and which will this year need to get about two-thirds of its food supply from over seas.

The Proposed Improvement of the Schuylkill Water Supply to Philadelphia.

The Schuylkill Navigation Co., presumedly, has issued a most excellent and telling exhibit in the shape of an atlas and pamphlet which discusses the desirability and possibility of improving the present Schuylkill water supply by acquiring the rights and works of the Navigation Co. As these works are now valueless to their owners for the purposes for which they were originally constructed, it is quite natural that they should desire to sell them for the best price possible to the only possible purchaser, the city of Philadelphia. This fact has given rise to much opposition to the scheme for some years past, and we must confess that originally we also regarded this project with some suspicion.

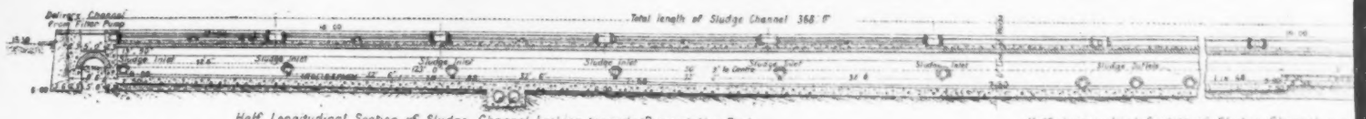
But an inspection of the excellent maps prepared by Mr. E. F. SMITH, the Chief Engineer of the Schuylkill Canal, and a study of the conditions, as near as these can be determined from his and other reports, lead us to modify this view, at least as far as the engineering and economical features are concerned.

Philadelphia is practically confined for its possible water supply to the rivers Delaware and Schuylkill, or to some of their tributaries. The supply up to this time has been drawn from the Schuylkill, at the very threshold of the city, and without other cost, as far as the water supply is concerned, than the building of a dam, and, later, the construction of an inadequate intercepting sewer. As Mr. SMITH says, this water supply has been a gift, as compared with the millions expended by other large cities to bring water to the consumers for distribution. The present system means the use of water that is much contaminated with sewage at times, muddy at others, and generally condemned by chemists as unfit for domestic purposes. This trouble grows with the extension of the city and increase of manufacturing establishments, despite attempts to intercept and carry below the dam objectionable matter. It is only a question of time when the Fairmount pool, now in the heart of the city, must be abandoned as a source of supply, and the question is what shall then be done.

In the past few years elaborate surveys have been made of the available watersheds within a radius of about 90 miles north and west of the city. The general result of this investigation is that the Delaware, tapped at the Water Gap, would give the largest supply, the one least liable to future contamination and having the advantage of being delivered to the city by gravity. But the distance, some 90 miles, and the enormous cost involved makes this project impracticable. Mr. HERING, in his careful report upon the future water supply, recommended the use of Delaware water obtained at Point Pleasant, and delivered at an elevation of 170 ft. above city datum. His estimates for this scheme ranged from $19,622,543, for 210,000,000 galls. daily pumped to an aqueduct by steam, or $15,475,262 if about 120,000,000 galls. were pumped by water and the remainder by steam power. Director WINDRIM, of Philadelphia, in his last report, recommends the impounding of the waters of the Perkiomen and Tohickon creeks, with a storage capacity of 25,000 million gallons, at an elevation of 300 ft. above city datum. He estimates the cost at $16,000,000.

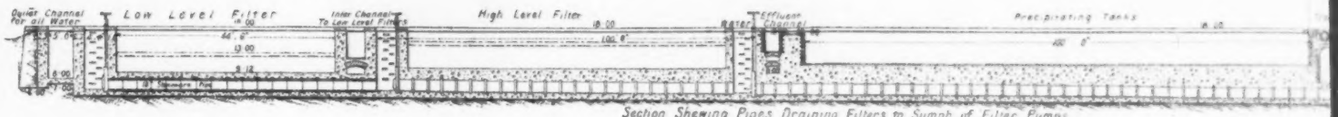
The proposition of the Navigation Company can be generally stated as follows: This company owns a combination of canal and slack water navigation, formed by dams across the Schuylkill, extending up this river to a point beyond Pottsville. It also owns a number of water rights, enabling them to store water at various points in the water shed. Including these reservoirs with the pools formed by damming the river, the total storage capacity is figured at about 4,452 millions of gallons. Above Norristown the water of the Schuylkill is undoubtedly very much purer than it is at the present intakes to the pumping stations in Philadelphia. And though Reading, with 50,000 inhabitants, drains into this stream above, the claim is made, and it seems to be proven by analysis, that the passage of the water over miles of limestone and sandstone formation, its aeration in transit and its subsidence in the numerous pools, purifies it by the time it reaches Norristown.

At the latter town the water would be inter-

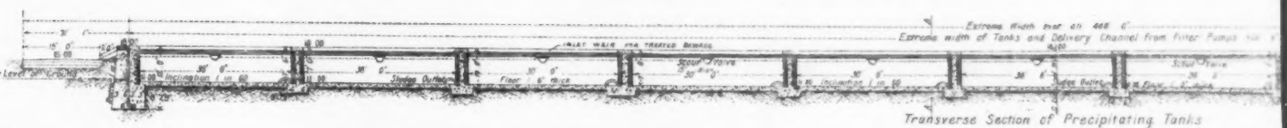

Total length of Sludge Channel 368' 0"
Half Longitudinal Section of Sludge Channel Looking towards Precipitating Tanks
Half Longitudinal Section of Sludge Channel

Outlet Channel for all Water
Low Level Filter
Inlet Channel To Low Level Filters
High Level Filter
Effluent Water Channel
Outlet Channel From High Level Filters

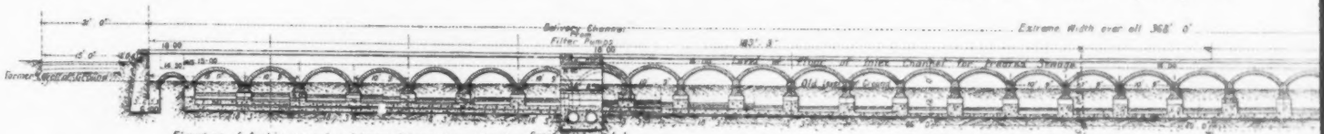
LONGITUDINAL SECTION THROUGH WORKS ON LINE A.A.



Section Shewing Pipes Draining Filters to Sumph of Filter Pumps

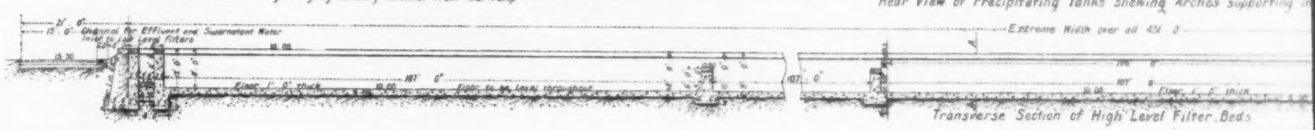


Transverse Section of Precipitating Tanks

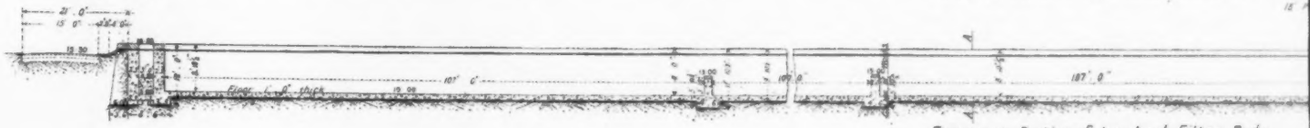


Elevation of Arching carrying delivery Channel from Filter Pump Cross Section L.L

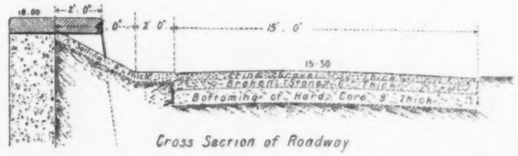
Rear View of Precipitating Tanks shewing Arches supporting

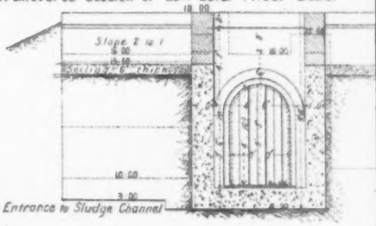

Channel for Effluent and Superatant Water Inlet to Low Level Filters
Extreme Width over all 451' 0"
Floor 1' 0" thick
Floor to be Level throughout

Transverse Section of High Level Filter Beds

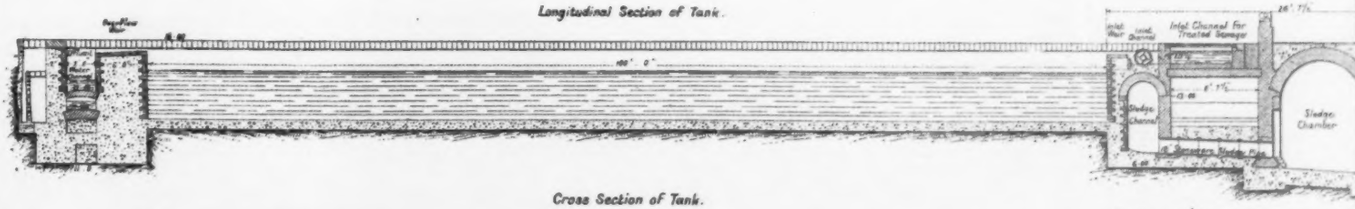


Transverse Section of Low Level Filter Beds.

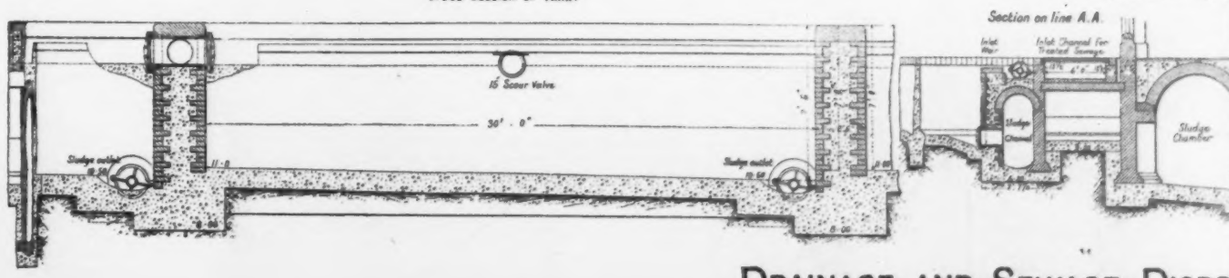




Longitudinal Section of Tank.

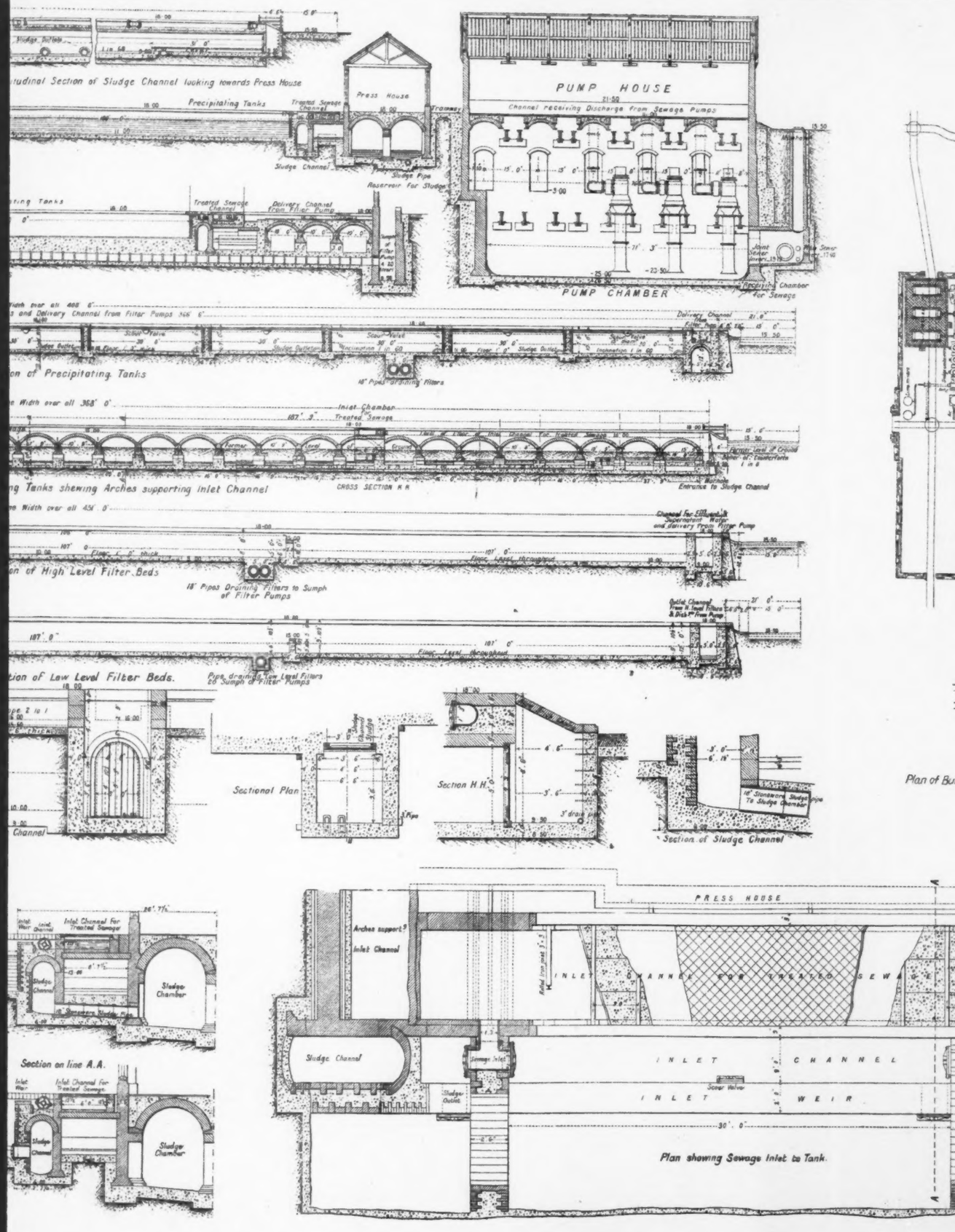


Cross Section of Tank.



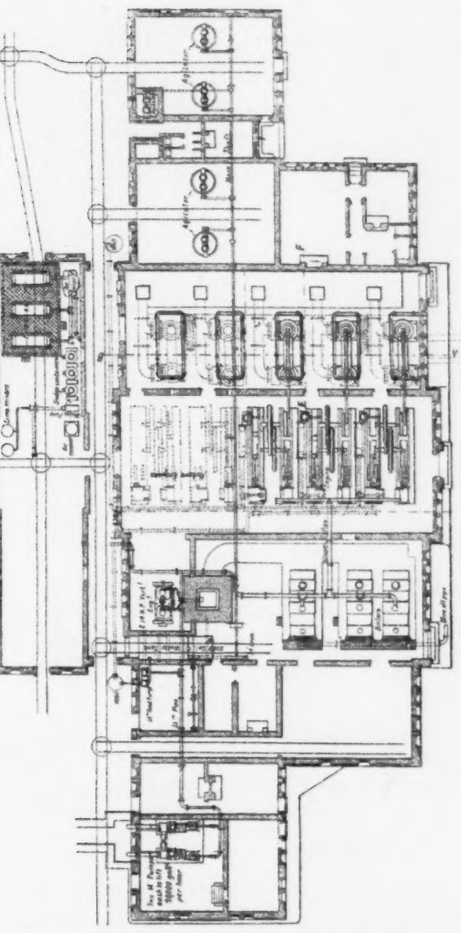
DRAINAGE AND SEWAGE DISPO

J. C.

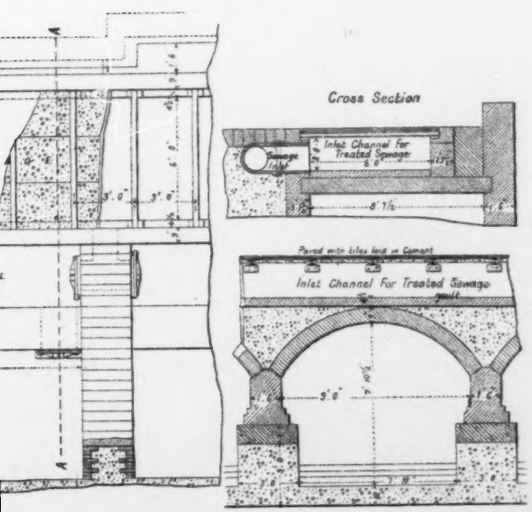


SEWAGE DISPOSAL WORKS AT RICHMOND, ENGLAND.

J. C. MELLISS, ENGINEER.



Plan of Buildings, Showing arrangement of Machinery, etc.



Cross Section

CHAS. HART & SONS, LITH. 35 VESEY ST., N. Y.

cepted and carried by two 8.6-ft. steel pipes along the river bank to the mouth of Arrowmink Creek, and then, to avoid the sharp bends in the river, in a tunnel a distance of 40,680 ft. coming out on the Schuylkill again. The Schuylkill would be crossed on a stone arch bridge, carrying steel 50-in. pipes, and connections would then be made with the present pumping stations. The water would be delivered to the pumps at such an elevation as to save from 11 to 32 ft. of lift, and the estimated saving in pumping is $50,000 per annum. The advantages claimed are a vast improvement in the quality of the water pumped, the utilization of the present pumping plant and reservoirs, the saving named in annual pumping expenses, and finally a low cost for the additional structures and work required. The total cost is estimated at $6,503,194.

If we are to suppose that the item in this estimate of $458,500 for "land and water-right damages, engineering and superintendence," covers all compensation to the Navigation Company, the scheme seems to be an economical one and would certainly improve the quality of water supplied to Philadelphia. The price to be paid for the rights and works of this company should have been explicitly stated, however, so that there could be no doubt about this very important point in the negotiation.

We cannot help expressing some doubt, however, as to the advisability of using for a public water supply the water of a river that flows through so thickly settled a watershed as that of the Schuylkill. It is true that able experts certify to the comparative excellence of the water above Norristown; but when this comparison is made with the water often pumped from the Fairmount pool, it is faint praise, to say the least. The drainage of cities like Pottsville, Reading and Pottstown must more or less contaminate the water with sewage flow, and if Dr. FRANKLAND is to be believed, no length of flow and subsidence will entirely remove all objectional germs. These may be deposited on the bottom and sides of the stream, but they are not destroyed, and may in time reach the inlet. Dr. LEEDS finds in the Schuylkill at Phœnixville traces of free and albuminoid ammonia, nitrous and nitric acid and chlorine, and while the amounts are such as to in nearly all cases permit him to class the fluid as "good water," these elements are there, and the water is to that extent not above suspicion.

On the other hand, Philadelphia needs at once some radical improvement in its water supply, and the comparative cost of this improvement is undoubtedly a very important item in the discussion of plans. The supply promised by the Navigation scheme is about 250,000,000 galls. daily, or say twice the present maximum demand; the water supplied would undoubtedly be better than that now in use, and finally the estimated cost, as assumed above, is about $10,000,000 less than any other project under discussion. Consequently the scheme has merits that should be seriously considered; even if it is only to be used as a temporary relief until such time as the city can afford to go further and pay more for a supply above suspicion and delivered at an elevation that will preclude the constant and very heavy outlay for pumping. But if the scheme is to cost any more than the amount stated, it would seem wiser to let the Schuylkill valley severely alone and to go toward the Delaware, where a better supply still can be secured, where the pumping plant could be concentrated for the present and would be more economical, and where all work performed would be on the line of an all gravity supply still further up the Delaware River. If the estimate of about $30,000,000 for an aqueduct and gravity supply from the Delaware Water Gap is anywhere near correct, this does not seem an extravagant cost for the water supply of the future city of Philadelphia, and it would seem much wiser to go in that direction even for a temporary service.

The Canadian Pacific Arbitration Case.

One of the most extraordinary litigations on record, keeping in view both the amount involved and the nature of the claims, has been ended this week by an award which must be very unsatisfactory to the plaintiff, but which must perforce be accepted, it would seem, since the defeudant was the Canadian government, and the tribunal a specially created one, from which no appeal can lie to any higher tribunal. Where some $15,000,000 was claimed, and probably a third of that sum or more expected, the award is only $579,000, with division of the costs, which have been very heavy. The circumstances may be thus outlined:

The Canadian Pacific Railway was begun as a government enterprise, it being supposed that no private company could be induced to undertake so long a line through (for the most part) an unsettled wilderness. The heaviest work was naturally undertaken first, including the section in dispute, some 226 miles of excessively heavy work through "the Fraser River country," in British Columbia. Contracts and specifications were out for the construction of this work in the costly style usual for government lines, as also for the section of heavy work between Port Arthur and Winnipeg, 431 miles, when it was decided to build the line by a private company after all. A part of the heavy inducements offered to this company (see ENG. NEWS, Sept. 22, 29, 1888) was that these two specially costly sections were to be finished by the government complete and presented to the company as a free gift, ready for operation. So much is admitted; but just how these sections were to be finished was left judiciously (or injudiciously) vague, the company perhaps expecting that the government would do the work over-well if anything, after the usual manner of government public works, and the government officials not knowing exactly what they would do, and evading any more specific conditions than that the Pacific work should be finished up to the standard of the Union Pacific Railway in the United States.

Unfortunately for the Canadian Pacific, the conditions of the two lines were widely different, and neither the company nor the government exactly comprehended how different, nor took pains to fully inform itself, which at that time it was difficult to do. In the comparatively solid earth and rock of the Union Pacific, 1 to 1 side slopes in cuts, untrimmed rock cuts, temporary wooden trestles to be filled in later with earth, etc., answered a very good purpose. But the British Columbia section, besides being very heavy, lies through some of the most extraordinary material in the world. The rock is almost all badly shattered by volcanic convulsions, and lies with a sharp dip toward the side hill roadbed which prevails for some 200 miles. The earth is more like a vast heap of dry ashes than like any other known material. It takes a natural slope of precisely 1½ to 1 over many thousands of square miles and for unbroken heights of 1,000 ft. or more; it has no coating of loam on top; it is dry to a great depth because of the lack of rain, though on the other hand cloudbursts of great severity sometimes occur. Consequently, if one cuts a hole a foot deep into any one of these slopes, the material will commence to run down and continue to do so for weeks, forming a new slope under and exactly parallel with the old one, which gradually extends itself upward, perhaps for hundreds of feet.

Similarly, a side hill fill can never be made to hold (except on the few easy slopes) till it extends clear down to the foot of the mountain. And if there chance to be a river there, as was generally the case along the line, the new slope will not hold at all unless the bottom be thoroughly protected by a retaining wall. There were of course variations in the material. Some was an ash-like powder, some fine sand, some coarse, some gravel, and some round boulders, but all assorted by water to nearly uniform size in any one locality, all dry, and all taking the same slope. These slopes were so amazingly uniform, and so unbroken by gullies or rounding of corners, that they were given the generic name of the "adzed slopes," than which no name could be more descriptive. Even if hundreds of feet high and a thousand or two feet long on the crest, as they often were and are, these slopes had their top and bottom angles as sharply defined as if they had just been dressed off by a gang of navvies.

Under these circumstances, what the spirit of the contract called for was that the line should have been made *as safe* and as nearly permanent as the Union Pacific's. What the Government did through its amorphous and ill organized local engineer corps—which as a whole was most improperly negligent and as clay in the hands of the contractors—was this: No attention whatever was paid to the utter difference of material and of conditions on the two lines, but whatever the Union Pacific line had done through good material, that the Government did through the worst of bad material. Deep rock cuts dribbling with semi-detached masses were left undressed and have since been continually dropping pieces on the track. Earth slopes of 1 to 1 were used through out, though it was only with great difficulty and constant work in clearing out that they could be made to stand even while the track was being laid, and this they did only because the slopes would form themselves into a changing series of short verticals and short 1½ to 1 slopes which could be seen to be continually dribbling and reforming. Fills were eschewed almost wholly, except in rare cases where the surface bore some approach to a level. Enormous cuts were wasted down the side hill (with great profit to the contractor) and short gaps between closed with timber trestles (also with large profit). Piling for these trestles was never used—it was expensive—but mudsills only; and as it was impossible to excavate a flat bed even temporarily for the mudsills of an entire bent, sills were eschewed, and a type of "grasshopper trestle" invented, each post of different length and resting on independent mudsills. The foundation of such a trestle on an ash slope of 1½ to 1 was naturally not over-secure, but whether on earth or rock it could never be filled in without retaining walls. Therefore when filling seemed imperative or desirable, a kind of timber cribbing locally known as "crib-wharfing" was used, consisting of a rectangle of notched logs filled with stone or gravel and buried in the bank, sometimes near grade, sometimes near the foot of the grade, sometimes half way up. Dry rot naturally set in in the interior while the exterior still remained sound, but the crib could not even be dug out for renewal without letting down the whole bank by re-formation of the slope on an interior parallel line. It was attempted to defend the use of these cribs to *sustain* high and loose slopes by alleging that they were a recognized expedient for protecting the toe of banks against river wash, but it is obvious that the two uses are not really parallel.

As a consequence of these and other like peculiarities of construction the line when "finished" and turned over was accepted only under protest, and was in a condition to require the expenditure of millions before it would be in a condition *as safe to operate* as was the Union Pacific, and it certainly constituted a disgraceful standard of construction for a civilized government to set to private corporations. But this arose chiefly or wholly from the marked peculiarities of the material, and the carelessness shown in directing the vast expenditure to the best advantage. The Government has claimed, and it seems now with effect, that their side-slopes, non-trimming of rock slopes, use of trestles in place of fills, etc., were paralleled in Union Pacific practice, and that, *there-*

fore, they had done all that was nominated in the bond. Like the Tilden will decision, this may be good law, but it is not good sense, nor is it equity. From one point of view it is ill to look a gift horse in the mouth, but from another and juster point of view this was by no means a gift horse, besides which, a contract is a contract, and a national government should not set the example of sharp practice under it.

The Past and Future of New York City Passenger Traffic.

The statistics of New York City internal passenger traffic for the year 1891, as abstracted in another column, continue to show the same rapid growth which has been conspicuous for many years past, and which affords the best possible guarantee of the financial success of the proposed new rapid transit lines, however great (within reason) their cost be assumed to be. Just at this time it may be of interest to review the reasons which seem to assure that this very rapid growth of traffic cannot cease for many years to come if it be not checked by lack of facilities, but must on the contrary give a very large traffic to the proposed new lines.

The underlying truth which assures this result is one little understood in a formal way, but which nevertheless is as demonstrable as any in social statistics, viz., that city traffic tends to increase as the *square* of the population rather than in direct ratio thereto, provided adequate facilities be afforded. That this is in accordance with the facts is conclusively shown by the little table below. That it is in accordance with theory and probabilities is readily seen by reflecting that in a city of 2,000,000 inhabitants as compared with one of only 1,000,000, there are (1) just twice as many people whom each inhabitant is likely to have occasion to meet, and (2) just twice as great an average distance to be traveled over in order to meet them. Because of the last of these conditions the proportion of riding trips to walking trips grows steadily larger, and there will be many double fares; and because of the first the number of trips which each inhabitant has to make in the course of a year also grows larger. Except for the fact that a large allowance must be made for that element of the daily travel which consists of two trips per day for each male adult to and from his daily occupation, and more so, traffic would tend to increase as the cube rather than as the square of the population.

That the law has been substantially as stated in New York City will be immediately evident from the following little table, which we abstract and extend to date from one given in more detail in the "Economic Theory of Railway Location,"* where the law above stated was first laid down and discussed theoretically and statistically. We regret that it is impossible for us to give the full table for each year of the period covered, which would make the table still more striking:

Growth of City Passenger Traffic per Inhabitant in New York City by Half Decades, 1853-1891.

Year.	Population 1 = 1,000.	Total No. pass. trips yearly 1 = 1,000.	Number of yearly trips per inhabitant.			Trips per inhab. per 1,000 *of pop'n.*
			Surface.	Elevated.	Total.	
1853....	581	6,836	11.8	....	11.8	2.0
1855....	630	18,488	29.4	....	29.4	4.7
1860....	814	36,455	44.7	....	44.7	5.5
1865....	876	82,055	93.8	....	93.8	10.7
1870....	942	115,139	122.0	....	122.0	13.0
1875....	1,045	166,918	158.8	0.9	159.7	15.3
1880....	1,206	211,222	124.7	50.5	175.2	14.5
1885....	1,437	297,117	134.7	71.8	206.5	14.4
1890....	1,711	404,399	127.6	108.3	235.9	13.8
1891....	1,772	430,853	129.5	113.4	242.9	13.7

The first column of this table gives the population, which is interpolated in due geometric proportion for the years between the several censuses, using for 1880 and all previous years the U. S. census, but for 1890 the enumeration made by the New York City authorities (1,710,715) instead of the smaller U. S. census figures (1,513,501). Using this larger population (if it be too large) is putting the law we stated to a pretty severe test, and it is probable that the true population lies somewhere between these two figures, for comparison with prior censuses at least, since all the U. S. censuses are probably somewhat too small for New York, because of the time at which they are taken (June 1–15), when many city residents are absent.

The second column of the table gives the total number of passengers in both elevated and surface street railways in New York City, returns from the elevated first beginning in 1872.

The next three columns give the total number of yearly trips *per inhabitant*, for the elevated and surface lines separately and in total. It will be obvious that if the traffic per inhabitant increased or tended to increase in direct ratio to the population only, this column would show a nearly constant total for all years; whereas, in fact, it shows an enormous and steady increase from 12 trips per inhabitant in 1853 to no less than 243 trips per inhabitant in 1891. The progressive increase is so regular and steady, and shows so little sign of stopping, as to make it at once evident to the most unobserving eye that the traffic not only has increased but tends to increase very much faster than in direct ratio to population.

The next and last column, which gives the number of yearly trips *per inhabitant per* 100,000 *of population*, indicates at once what is the real law which has governed the growth of traffic in the past, and which will presumably govern it for the future. It needs but a glance at this column to see that since 1870 it tends to remain nearly constant at 14.0; and it needs but a moment's reflection to see that, so long as it does remain constant, it means that city traffic is increasing as the *square* of the population, because when the population has doubled we have twice as many trips per inhabitant × twice as many inhabitants = 4 times as many passenger trips per year, and proportionately for smaller increases.

Will this ratio be maintained for one or two decades yet to come at least? There are at least strong reasons why it should be so maintained, provided only that adequate facilities for such growth be provided, as they will be by the proposed new rapid transit lines. In the first place, it is well known that with the exception of a brief period in 1876-82-3 the existing facilities have lagged far behind requirements. The elevated lines are not able to expand their facilities with the demand by lengthening their trains and platforms, as can the underground lines. At least they think they cannot, and at any rate they do not, though electrical propulsion now opens the way to it.

In the second place, the apparent tendency to a slight decrease in the ratio of trips per inhabitant *per* 100,000 *inhabitants* in the last column is only apparent, being due to our using the largest estimate of population, as above noted. Had we used the United States census population for 1890 the ratios in the last column for 1885, 1890 and 1891, instead of standing at 14.4, 13.8 and 13.7 would have stood at 16.3, 17.0 and 17.3 respectively, thus showing a decided tendency in this ratio to increase rather than decrease, as a glance at the table will show, which would mean that the traffic was increasing faster than the square of the population and not slower.

Taking a kind of average of these figures the present number of yearly trips *per inhabitant per* 100,000 *inhabitants* is more likely to be 15 than 14, and increasing rather than decreasing. There must come a time in the growth of a great city, of course, when this ratio must decrease, or the number of trips per inhabitant would become too large for possibilty. For example, in a city of 5,000,000 it would give 50 × 15 = 750 trips per year per inhabitant, against the present 243 in New York, which if not entirely impossible is a most improbable aggregate. But for the present we are hardly in sight of any such natural limit, and the past ratio may be expected to continue.

This being so, let us see what kind of a traffic it indicates for the next 10 to 20 years. We will assume that the population of 1891 is 1,700,000. Instead of the ratio of 25½ per cent. increase per decade which the 1890 census indicates, or the 42 per cent. per decade which the city enumeration indicates, we will assume 33⅓ per cent. per decade as the probable ratio of the growth of New York (including the annexed district) for the next 20 years. With good rapid transit facilities we see no reason why this ratio should not be obtained.

These two assumptions give us the first two columns below, and the next two follow by simple multiplication. We add the figures for 1870 and 1880 for comparison.

Actual Past and Estimated Future City Passenger Traffic of New York City.

Year.	Population.	Trips per inhab. per 100,000 inhabi'nts.	Total trips per inhabitant per year.	Thousands of yearly trips on all lines.
1870.....	942,292*	13.0*	122*	115,139*
1880.....	1,206,299*	14.5*	175.2*	211,222*
1891.....	1,700,000†	15.0‡	255‡	433,500*
1901.....	2,267,000†	15.0†	340†	770,780†
1911.....	3,023,000†	15.0†	453†	1,369,420†

*Actual. †Estimated. ‡Actual, except for a small possible error in the estimated population for 1891.

Does the last column show an almost incredibly rapid growth of city traffic, hard to look on as possible? It does. So would the record of to-day have seemed 20 or 10 years ago. But that it is a tolerably accurate estimate of the rate of growth for the next decade at least, we cannot doubt. After 1901, however, the rate of growth is likely to be less than that shown, for the yearly trips per inhabitant given in the last line approaches very close to the natural limit which can never be exceeded under any circumstances, and would not be likely to be approached except for this fact: As the city grows a larger and larger proportion of the passengers are making long trips and paying a double fare. If all residents north of the Harlem River, for example, may be assumed to pay double fare to reach the City Hall, which will still be cheap traveling, the traffic given for 1911 in the last line, even, becomes readily attainable. It is always to be remembered that when the population of New York City become 3,000,000 or over more than 1,000,000 of them are likely to live north of the Harlem River.

Be this as it may, the above table holds out the certainty of an enormous traffic for the new Broadway lines long before 1900, as may be seen from the following facts not yet noted. The surface street railway traffic now increases very slowly. In *thousands* of passengers it was:

	Surface.	Elevated.
In 1875.....	165,997	921
In 1880.....	150,390	60,832
In 1885	193,762	103,355
In 1886.....	206,802	115,110
In 1890.....	218,565	185,534
In 1891...	229,651	201,202

In 1901 neither the surface nor the elevated traffic can well amount to over 250,000,000 each, or 500,000,000 in all, leaving 270,780,000, or $13,533,000 per year to the new underground lines if built; but even when first opened the new lines have only to draw 20 per cent. of the existing traffic from the surface and elevated lines (which is about what the elevated drew from the surface lines), and to increase the total traffic one-third, (which is about what the elevated did) to have 230,000,000 passengers from the beginning. And the new lines will have this advantage over the elevated, that as soon as its first 3 to 4 miles of track are open it will begin to earn heavily from short trip travel, owing to its location under Broad-

* "The Economic Theory of the Location of Railways," by A. M. Wellington, M. Am. Soc. C. E., pp. 714-5.

way, whereas the elevated lines did not begin to earn largely till they were substantially complete.

Taking all these facts into consideration there cannot be a reasonable doubt that the new underground lines will be a financial success from the very beginning, and will have in less than a decade a traffic which will be limited only by its capacity to decently provide for it.

THE LADD OBSERVATORY was formally presented to Brown University, at Providence, R. I., last week. This is a gift of Gov. H. W. LADD and includes a building 43 × 27 ft., of brick and stone, with a dome 21 ft. in diameter The telescope is 15 ft. long with 12 in. aperture and a complement of scientific apparatus. It was made by G. N. SACMULLER, of Washington, D. C., and the optical work was done by JOHN A. BRASHEAR, of Pittsburg, Pa. It cost $9,000, including the spectroscope.

A RUSSO-CHINESE RAILWAY is reported as the objective point of negotiations now going on between Russian and Chinese representatives. Russia wants the right to build a railway from Vladivostock, the Pacific terminal of the proposed Siberian railway, across the northern boundary of Corea to Tien-Tsin, and thence to Shanghai. The alleged object is quick transit of Chinese tea and silk to Europe. The Chinese, however, are already very jealous of Russian influence in the East, and will probably decline Russian aid in railway building.

PROGRESS ON THE MEMPHIS BRIDGE to Oct. 18 is reported as follows by our correspondent: The anchorage span and first cantilever arm are erected. The center span is swung. This latter span is 621 ft. 0½ in. long c. to c., with a depth of truss of 77 ft. 7⅛ ins. As this span had to be erected on false works and at a favorable stage of the river, it was the one that gave most anxiety. The grading for both approaches is nearly completed. The first iron for the west approach is now arriving, and it is probable that the bridge will be finished within the next 9 months.

THE WATERWAYS CONVENTION, held at Evansville, Ind., was presided over by ex-Gov. E. O. STANNARD, of Missouri. The subjects discussed were the Mississippi and Missouri river commissions, the Hennepin Canal, the improvement of the Ohio and Cumberland rivers, an 8-foot channel in the Mississippi from St. Louis to Cairo and the general subject of the comparative cost of transportation by water and by rail. The executive committee was reorganized with 15 members from each state, and the plans and methods of the Mississippi and Missouri river commission, and of the government engineers were commended and approved. The convention recommended appropriations for the completion of locks at bayous Plaquemine and Lafourche, and for dredging Old River, at the mouth of Red River. It also heartily approves of the legislation of the Forty-first Congress in connection with the construction of the Illinois and Mississippi Canal from Rock Island to Hennessy, on the Illinois River.

THE NORTH RIVER BRIDGE CO., of New York, has filed the annual report of the directors with the Inter-State Commission, for the year ending Sept. 17, 1891. From this report it appears that the company has about completed the preliminary work prerequisite to actual construction. This bridge is the double-decked structure designed by Mr. GUSTAV LINDENTHAL, M. Am. Soc. C. E. It has a capacity of 14 standard gage railway tracks, and would extend between Bloomfield and Twelfth Sts., in Hoboken, and Twenty-third St. and Tenth Av. in New York. From the latter point a steel viaduct would carry the 14 tracks to a high-level station on Sixth Av., extending from Twenty-fifth to Twenty-eighth Sts., with a connection with the yards of the New York Central on Thirty-ninth St. The estimated total cost is $70,000,000, but the report submits full estimates of probable traffic and receipts from this outlay. The report is signed by Messrs. JORDAN L. MOTT, E. F. C. YOUNG, C. J. CANDA, J. KING MCLANAHAN, WM. BROOKFIELD, THOS. F. RYAN and JAMES ANDREWS.

CORRESPONDENCE.

Steel Foundations.

JACKSON, Mich, Oct. 14, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the ENGINEERING NEWS of Oct. 3 appeared a letter from Mr. WILLARD M. CLAPP, in which he attempts to definitely answer my communication of Aug. 11, wherein I pointed out certain omissions in the calculations given in Mr. PURDY'S article on "Steel Foundations," but in which Mr. CLAPP fails to answer it in the slightest degree. His chief anxiety seems to be to show that the foundation referred to is not unsafe, which was not questioned by me. He says that my failure to compute the foundation as a built beam is an oversight; but I cannot understand why it is. I made no attempt to give any new theory for the calculations, but simply to call attention to an omission in the calculations given by Mr. PURDY. In his article not the slightest allusion was made about computing the foundation as a built beam; why, then, should I so compute it in calling attention to an omission in his calculations?

Mr. CLAPP asserts that to compute the foundation as a built beam is correct; if so, why was it not so computed and given in Mr. PURDY'S article? If it was so computed and designed, it is certainly the greatest absurdity of design in the way of a built beam that has ever come to my notice.

Let us really consider it purely as a built beam, and se if it has sufficient strength as such. Passing over many incongruities of design we will take one instance, which will be sufficient, as one weak point in a beam limits its entire strength—the top chord of the beam formed by the three top courses, as Mr. CLAPP suggests.

In the eight inches contiguous to the base of the column we have a horizontal shear of 232,000 lbs. to be transmitted from the chord to the web, while the frictional resistance of the chord upon the web for the same distance amounts to not over 13,000 lbs. I take the coefficient of friction at .24 in order to make sufficient allowance for the friction of steel upon steel and concrete. (TRAUTWINE gives it as .14 for steel upon steel.) To this resistance must be added the resistance to shearing of a small amount of concrete, for which we will allow 10,000 lbs., which will more than cover it. This gives an ultimate strength of not over 23,000 lbs. to resist 232,000 lbs. of stress, and this is making a liberal estimate of the amount of resistance, with no factor of safety.

This does not look as though the built beam has an excess of strength. It looks rather as if the foundation acting purely as a built beam has a good large deficit.

I give these figures merely to show the inconsistency of the position taken by Mr. CLAPP in his letter. All that is necessary to say in defense of my former communication is to state that in order to intelligently provide for the bending moment, whatever means may be taken to resist it, it is first necessary to calculate the entire bending moment to be resisted, which, in Mr. PURDY'S article, was not done.

And here it might be well to add that the sum of the bending moments, as given by the calculations in Mr. PURDY'S article, will in no case equal the total bending moment, nor in any way indicate the amount of it.

Now if Mr. CLAPP wishes to put himself on record as saying substantially that in order to provide for the resistance of a force it is only necessary to ascertain the amount of an indefinite portion of the force to be resisted, which portion in certain cases may not exceed 50% of the entire force, he has the full privilege.

Appearances go to show that the design of the foundation was based on the calculations given in Mr. PURDY'S article, and that the idea of considering it as a built beam was simply an afterthought which came while seeking some theory by which to prove that in spite of the insufficient calculations the foundation was not dangerous.

The point of danger was scarcely referred to in my former communication; in fact, I think that much better reasons than those given by Mr. CLAPP exist by which to prove that the foundation is not unsafe.

Much more can easily be said concerning this foundation, but I feel that I have already trespassed too much upon your space. BENJ. F. LA RUE.

The Democratic Candidate for State Engineer.

SOUTH BETHLEHEM, Pa., Oct. 24, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your editorial in this week's issue regarding the candidates for State Engineer in New York, you do one, at least, of the candidates a great injustice.

Hon. MARTIN SCHENCK is an engineer both by education and profession. He graduated as civil engineer from Union College in 1869, and was engaged shortly afterward for a few years on railway construction in Texas and Indian Territory. On returning to New York he became one of the firm of Morrell & Schenck, contractors. Subsequently he was engaged as engineer by one of the large contractors on the West Shore R. R. during its construction, and had entire charge of considerable difficult work.

During 1886 he was assistant on Hudson River improvement, and from 1887 up to and including the present year he has been engineer in charge of the Hudson River improvement under the State Engineer. (See State Engineer's Report, 1887, et seq.) During the winter of the same years he has had charge of lock enlargements on the Eastern Division of the Erie Canal.

He has never been employed as *foreman* on the capitol approach, but the Hudson River corps, of which he has charge, was called upon to do the necessary instrumental work required while the foundation was being laid.

I know Mr. SCHENCK personally and am sure he well fills the requirements of the constitution in being a *practical engineer*. I trust you will accordingly make this correction in your next issue so as to precede the coming election in your state.

Respectfully yours,

J. E. OSTRANDER,
Assoc. M. Am. Soc. C. E.

[While we are unable to change our own views of the situation, having regard to the important duties of the office, we give room with pleasure to this communication, which gives a much better professional record for the candidate than has heretofore been made public in his behalf. This record is probably sufficient to bring the candidate within the constitutional requirements in the eyes of a court, which appears, from their acts, to be all that the politicians of either party care for, if indeed they care for that.—ED. ENG. NEWS.]

ALBANY, N. Y., Oct. 26, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: An editorial in your issue of Oct. 24, just received, does injustice in our opinion to Mr. MARTIN SCHENCK a nominee for the office of State Engineer and Surveyor, in the statement you make of his professional experience and in the conclusion you properly draw from this erroneous statement.

The following is briefly the engineering record of Mr. SCHENCK: He graduated as civil engineer from Union College in 1869, and was directly afterward engaged in the engineer corps of the Missouri, Kansas & Texas R. R., on the Sedalia and the Neosho branches, upon both location and construction; he had immediate charge of construction of several railroad bridges in Kansas. In 1873 he was engineer for the contractors in the construction of the additional tracks of the New York Central R. R. From 1874 to 1880 he was engaged in private practice, chiefly water-works. During 1881 and 1882 he was engineer for the contractors in the construction of the West Shore R. R. On June 23, 1884, he was appointed rodman in the Department of the State Engineer of the State of New York; Nov. 1, 1884, promoted to leveller, and April 18, 1887, promoted to assistant engineer, passing civil service examinations for the original appointment and for each promotion.

Since that time he has been continuously assigned by the State Engineer to the charge of important works, as follows: During the summer seasons of 1887, 1888, 1889 and 1890, engineer in charge of the state improvement of the Hudson River. During the fall, winter and spring of 1887-8 engineer in charge of the construction of the new lengthened locks 31, 32 and 33 of the Erie Canal, a lift bridge at Fort Plain and two waste weirs, with two engineering parties under his direction. During the fall winter and spring of 1888-89, engineer in charge of the construction of locks 27 and 28, Erie Canal, and of works for increasing the draft of water on the Eastern Division. During the fall, winter and spring of 1889-90 in charge of construction of locks 23 and 24, Erie Canal; of an iron bridge at Schenectady; of half a mile of retaining wall for bank protection and of the improvement of the Albany Basin and of the channel of Rondout Creek. Since the close of the summer season of 1890 he has been in charge of the construction of locks 40 and 41, Erie Canal, and of the improvement of the Albany Basin. The State Engineer being a Supervising Commissioner of the Capitol, he has, with the approval of the Supervising Architect, detailed Mr. SCHENCK from time to time to attend to the engineering required in the very extensive masonry construction in progress; he has been detailed in the same capacity for the construction of the armory of the Twenty third Regiment in Brooklyn.

In the construction of these nine locks, and of the other canal works mentioned, he has reported directly to the Division Engineer of the Eastern Division and has been the responsible engineer in charge of these important and extensive works.

As engineer in charge of the State Improvement of the Hudson River during the seasons of 1887, 1888, 1889 and 1890, he has reported directly to and received instructions only from the State Engineer. His conduct of this work has been highly creditable and has resulted in permanent improvement of river navigation. His reports have been of sufficient importance in the opinion of the State Engineer to warrant their full publication in the Annual Reports of the Department for 1887, 1888, 1889 and 1890.

It will be seen, therefore, that Mr. SCHENCK was educated as a civil engineer, has been in active practice since he graduated in 1869, and has had actual responsible charge of a large amount of engineering work.

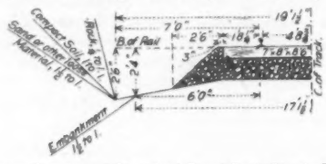
The publication in a professional journal of an erroneous statement of Mr. SCHENCK's engineering experience makes it a simple act of professional justice that we should state the above facts. Very respectfully,

E. SWEET.
State Engineer and Surveyor 1884-1887 incl.
JOHN BOGART.
State Engineer and Surveyor 1888-1891 incl.

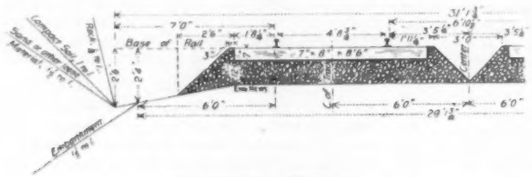
[By reference to the last report of the State Engineer we find that the engineering department of the State of New York is organized as follows:

		Salary.
1 State engineer		$5,000
1 Deputy	"	
3 Division	" each	2,400
3 Resident	" "	2,000
8 Assistant	" "	6.00 per day.
10 Levelers	" "	4.50 " "
18 Rodmen	" "	3.50 " "

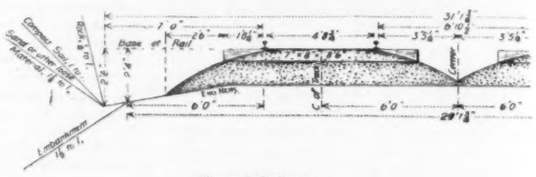
We also find that charge of work on the Hudson River improvements consisted of charge of one surveying party, costing $4,352.35; of 82,812 cu. yds. of dredging, done at a cost of $15,991.56; of $508.92 worth of stone filling on dikes; of 295 cu. yds. of rock excavation from Rondout Creek, and 47,027 cu. yds. of dredging in the Albany basin. With the aid of these notes our professional readers can form their own conclusions as to bearing of the facts enumerated in the above letter on the question of competency for the office of State Engineer.—ED ENG. NEWS.]



Half Cross-Section of Standard Road-Bed, Single Track.



Broken Stone Ballast



Gravel Ballast.

HALF CROSS-SECTIONS OF STANDARD ROAD-BED, DOUBLE TRACK.

Track Standards and Rules for the Government of Trackmen on the Baltimore & Ohio R. R.

For some time a committee made up from the engineering staff of the Baltimore & Ohio R. R. Co. has been at work on standards for use in the Maintenance of Way Department of that road.

A book of rules and in structions for trackmen has been prepared by the Committee, and was issued with General Manager J. T. ODELL's approval on Sept. 1, 1891. Accompanying it are engravings of standard sections of roadbeds for single track with side track adjacent, and double track, both on tangents and curves, and with gravel, broken stone and cinder ballast. We reproduce herewith the cross sections on tangents, adopted for single track and for double track with gravel and with rock ballast. We make the following abstract of the most interesting points touched upon in the rules:

ROADBED AND BALLAST.

The purpose of the ballast is explained, and stone, gravel and furnace cinder are specified as the materials to be used. Ash-pan cinder is permissible on branches where other material cannot be obtained. Rock ballast must be broken to pass a 2½-in. ring, and must be 12 ins. deep under the ties; gravel ballast should have the same depth, but the slope to subgrade should begin at the rail instead of at the end of the tie, as with rock ballast.

Where the ballast is very thin, or where there is none at all, the filling should be 2 ins. above the ties at the center of the track, sloping uniformly to 1 in. below the bottom at the ends of the crossties, and thence out to the bottom of the ditch. An inch space must be left under the rails for the passage of water from the tracks.

Between main track and sidings, large, coarse stone must be placed at the bottom, but not at the ends of the crossties.

In raising the track the tamp must be used on each tie from a point 4 ft. on each side of the rail and ballast simply shoveled in at middle. Special attention must be given that the tie is tamped directly under the rail, which, because it is a difficult point to reach, is apt to be neglected by the men. Tamp all ties as evenly as possible, and always tamp the joint ties last.

In using track jacks they must always be set on the outside of the rail. Serious accidents have resulted from trains striking them when set inside of rail, and no excuse will be accepted for this practice.

Road crossing planks are required to be ⅛ in. below top of rail, 2½ ins. from gage line, and beveled at ends and inside edges.

EMBANKMENTS AND DITCHES.

The need of bringing embankments and ditches to conform to the standard cross-section as rapidly as possible is emphasized. Embankments should be 17 ft. wide on top for single track and 29 ft. wide for double track. The tops should be kept free from grass; but on the slopes the growth should be encouraged to prevent washing. As far as possible all new ditches should be dug and all old ones cleaned for the winter season before Nov. 1. Each section foreman must, during October, make a special and careful examination of every culvert and drain in his section, and remove all brush and other obstructions to the channel for some distance, both above and below the railway, and make a report of each culvert to the supervisor.

CROSSTIES.

All crossties used in the main track must conform strictly to the following specifications: Material, sound, white chestnut, burr or rock oak, free from wind shakes; length, 8½ ft. on lines east of Ohio River, and 8 ft. on lines west of Ohio River, with the ends sawed square; thickness, 7 ins.; face, nowhere less than 7 ins.; if split ties are furnished, not less than 8 ins.

Ties must be hewed to the exact thickness with parallel faces throughout. All bark must be entirely removed. Accepted ties must be distinctly marked "B. & O." in red. Special attention must be given to the length of ties, and none may be accepted which do not conform to specifications.

Crossties should, as far as possible, be laid early in the season, so that all track work in the summer will be on sound timber. To effect this the section foreman must, during the month of September, determine by actual count, and not by estimate, the number of crossties he will need on each mile of his section during the ensuing season, and report to the supervisor, who will make requisition on the division engineer.

The ends of all crossties must be lined parallel with the rail on the right-hand side going west on single track and on the two outside ends on double track.

In all new work not less than 16 ties must be placed under each 30-ft. 67-lb. rail, spaced evenly. Under heavier rail the number may be reduced as instructed by the division engineer. The largest and best ties, if there be any variation in width, must be placed at the joints, and the ties next to the joints should be as nearly as possible of the same size. When repairing old work, any previous improper spacing must be corrected according to these instructions.

The proper spacing of crossties for the suspended angle joint is 10 ins. in clear between the edges of the two joint ties, and not more than 14 ins. between the edges of the intermediate ties.

The proper spacing for the supported joint is 9 ins. from the edge of the joint tie to either of the shoulder ties. The other ties must not be placed more than 15 ins. apart.

The remaining instructions under this head are in substance that ties must be laid at right angles to the track, must be adzed if necessary but never notched; and must not be removed from the track while still good and serviceable. All rods at stub switches must be protected by placing them between two crossties spaced 3 ins. apart. Wooden spikes must be kept on hand and used to plug all holes made by drawing spikes from sound ties.

RAILS, SPLICES AND SPIKES.

Rails must never be unloaded from cars in motion. Any crooked or bent rails must be straightened before laying. Defective ties must be replaced with new ones before laying new rails, and the track must be surfaced. In laying track use iron shims (not wooden chips) to separate the ends of the rails. Proper thicknesses are: In coldest weather $\frac{5}{16}$ in.; during spring and fall, ⅛ in.; during very warm weather, $\frac{1}{16}$ in. Worn rails used in repairs must be used with rails of similar pattern, with step chairs at every point of junction of rails of different heights.

Low joints are the most fruitful source of lamination, breakage and damage to rails. As soon as one is seen trackmen must stop and raise it on stone, even if the latter has to be hauled a considerable distance in a push car.

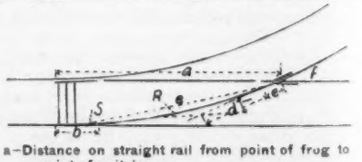
All track must be laid with broken joints; that is, the joints in one line of rails must be as nearly as possible opposite the centers of the rails of the other line.

In spiking, the outside spike of one rail must be opposite the outside spike of the other rail, and the inside spikes must also be opposite; this must be observed on straight lines as well as on curves. In sidings between the clearance posts only half spiking is permissible. Spikes must be driven perpendicularly, and no spiker may lean the spike outward or inward to suit the swing of his sledge. Rails must not be drawn to gage by a spike. Throw the rail to gage with a bar and drive the spike straight.

All spring frogs must have iron rail braces not more than 2 ins. from the fly rail. Switches must have the proper lead, and rails must be cut when necessary to make exact length. The following table is given for lengths of the lead. The first three turnouts are hardly likely to be used, and the reason for including them in the table is not apparent.

TABLE OF STANDARD SWITCHES.

Frog. number.	Frog. angle.	Length of split switch.	Angle of switch.	"E," Straight wing of frog.	"A," Distance on straight rail from point of frog to point of switch, ft.	Radius of outside rail, ft.
1	53°.08′	7 ft. 6 ins.	3°.11′	2 ft. 0 ins.	13.7	6.80
2	28°.04′	"	"	"	21.2	29.0
3	18°.56′	"	"	"	28.1	69.7
4	14°.16′	10 ft.	2°.23′	"	37	129.5
5	11°.26′	15 ft.	1°.35½′	"	51.3	200.1
6	9°.33′	"	"	"	57.8	295.2
7	8°.10′	"	"	"	64.3	412.7
8	7°.10′	"	"	"	70.0	548.0
9	6°.21′	"	"	"	75.7	708.1
10	5°.44′	"	"	"	80.8	885.1
11	5°.12′	"	"	"	86.3	1,102.5
12	4°.46′	"	"	"	91.3	1,343.4
13	4°.24′	"	"	"	96.1	1,616.9
14	4°.06′	"	"	"	100.4	1,908.2
16	3°.35′	"	"	"	109.2	2,653.4



a—Distance on straight rail from point of frog to point of switch.
b—Length of split switch.
S—Angle between switch rail and main track rail.
f—Frog angle.
e—Distance from point of frog to point of curve.
d—Distance from P. C. to intersection.
R—Radius of outside rail.
I—Angle of intersection.
g—Gage.

FORMULAS.

$$d = \frac{g - (\sin f\, e + \sin S\, b)}{\sin f + \sin S.}$$

$$R = \frac{d}{\text{Tan } \frac{1}{2} I.}$$

$$a = \text{Cosin } S\,(b + d) + \text{Cosin } f\,(d + e).$$

$$I = f - s.$$

$$c = \text{Cosin } \tfrac{1}{2} I.\, 2\, d.$$

Guard rails in main track must be at least 15 ft. long, placed not more than 2 ins. from the main rail, and braced with not less than 3 braces. All facing-point switches must have a guard rail not less than 10 ft. long placed in front of switch on side of continuous rail.

As rails are removed from the track, place at once all those that are good for future use on the north or east side of the track, and all those that are unserviceable on the south or west side. As far as practicable, these piles should be made near mile-posts.

Standard gage is 4 ft. 8¾ ins; on sharp curves the gage may be widened to not more than 4 ft. 9 ins.

In elevating the outer rail on curves, section foremen are to be guided by two tables, one applying to single track lines or to double track lines where the grade is descending or light ascending, the other applying to steep ascending grades on double track lines where trains always move in the same direction. To determine the degree of the curve, the instructions are to measure the middle ordinate of a 50-ft. chord along the inner rail of the curve. For curves sharper than 10°, special instructions must be obtained from the division engineer or supervisor as to the amount of elevation; but in no case must the elevation of the outer rail exceed 8½ ins.

The following are the figures given in the two ables for elevations on curves of even degree:

Degree of curve.	Elevation for single track or light grade double track lines.	Elevation for steep ascending grades on double track.
½	⅛ inch	⅛ inch
1	1⅛ "	⅝ "
2	2⅛ "	1⅛ "
3	3⅛ "	2 "
4	4⅛ "	2⅝ "
5	5 "	3 "
6	5⅝ "	3⅝ "
7	6 "	4¼ "
8	6⅝ "	4⅝ "
9	7 "	5¼ "
10	7⅝ "	5¾ "

Where the schedule time of trains exceeds 40 miles per hour, special instructions must be obtained by the foreman for increasing the elevation.

Foremen are cautioned to measure the middle ordinate at several points and not be misled by sharp or flat places (which if found should be corrected). Compound curves are explained, and foremen are instructed to give the point of compounding the full elevation due to the sharper portions. Curves should have full elevation at the ends, and the rails should ordinarily slope down to the level of the inner rail on the tangent with a drop of 1 in. to each 30 ft. rail. In case of reverse curves, however, or of curves with very short tangents between them, all or part of the elevation must be given after entering the curve.

Standard rail braces must be used on both inside and outside rails at centers and quarters on all curves having 2 ins. or more elevation of outer rail.

On tangents foremen are instructed to make frequent use of the level board.

TRACK TOOLS AND SUPPLIES.

The usual rules as to the use and care of hand and push cars are given. For the custody of tools the foreman is responsible. A list of all necessary tools, furnished by the supervisor, must be kept on hand, and inspection must always show tools corresponding to this list; a tool wearing out or breaking in use must be replaced by a new one, for which the foreman will make requisition. The new tool will be issued, however, only on the return of the old one to the Supervisor.

TRACK WALKING.

Every morning the foreman must send a reliable and experienced man to walk over such portion of the section as will not be seen by the foreman during the day. This man is to replace missing bolts and nutlocks and broken spikes, raise low joints, look for broken rails and burnt joint ties, examine frogs, switches and switch locks, pick up loose spikes, bolts, &c., watch for fires, repair fences, close farm gates, and do anything and everything to protect the railway from accident.

During heavy rains and storms, every man, if necessary, must be placed on duty and the entire section must be watched. Culverts and drains must be examined and all driftwood immediately renewed.

Bridge watchmen must follow every train and extinguish any hot cinders that may have fallen from the engine. They must, as far as possible, prevent all persons except employees from crossing the bridges.

ACCIDENTS.

In case of train accidents the nearest section foreman must go to the relief of the train with his entire force, even if it be off his own section. When different gangs arrive at a wreck the senior track foreman will have charge until the arrival of the superintendent or the division engineer. After clearing up the wreck, each foreman must gather up the tools of his own gang, which should have some distinguishing mark. Prompt reports must be made to supervisors by foremen of all accidents, injuries to persons, property or stock, and of fires set by locomotives.

The rules for policing and for the running of construction trains are quite explicit, except that the precautions to be taken by the latter when working or running on the main track to prevent obstruction or collision with regular trains are not mentioned. Probably this is left to the operating department.

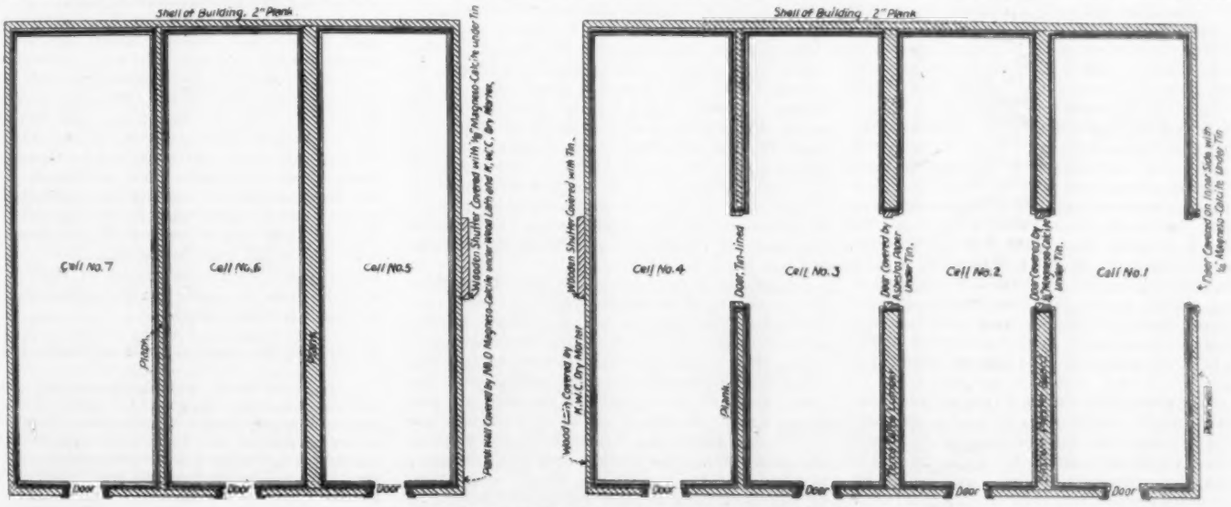
The standard 85-lb. rail and splice adopted for the Philadelphia division of the Baltimore & Ohio was shown in our issue of July 18. The standards for track warning and distance posts we shall illustrate next week.

Tests of Fireprcofing Materials at Boston.

BY F. E. CABOT.

A test of various materials intended for use in the interior finish of buildings, and for which more or less fireproof qualities are claimed, took place in Boston on Thursday, Oct. 15. Some small buildings were erected for the tests on a vacant lot of land at the corner of Union Park and Albany Sts., adjoining the new power house and erecting shop of the West End Street Railway.

As will be seen by the accompanying diagram, two buildings, one of three compartments and the other of four compartments, were built of spruce plank and placed adjoining each other, so that the distance



TESTS OF FIREPROOFING MATERIALS AT BOSTON.

Cell No.....	7	6	5	4	3	2	1
FLOOR	No. 4 magneso-calcite covered by board floor.	Two thicknesses of No. 0 Magneso-calcite. Above it is K. W. C. dry mortar on wooden lath, and a coat of albamural over all.	Asbestos paper covered by board floor.	King's Windsor cement dry mortar covered by board floor.	Kings Windsor cement dry mortar covered by board floor.	Porous terra cotta lumber. (Best Fireproofing Co).	Two thicknesses No. 1 magneso-calcite, covered by board floor.
CEILING.....	No. 19 Clinton wire lath, ⅜ in. band iron, covered by lime and hair mortar.		King's Windsor cement dry mortar on wooden laths.	K. W. C. dry mortar on New Jersey wire lath.	K. W. C. dry mortar on Clinton wire lath.	Dry mortar on Clinton wire lath.	K. W. C. dry mortar on Clinton wire lath under plank roof.
SIDE WALLS	*Front.* Lime and hair on Clinton wire lath.			*Front half.* Fine mesh N. J. wire lath covered by dry mortar.	*Front, back and left side* K. W. C. dry mortar on Clinton wire lath.	*Front and back.* K. W. C. dry mortar on Clinton wire lath.	*Front and right side.* K. W. C. dry mortar on wood lath.
	Back. K. W. C. dry mortar on ¾ in. mesh Clinton wire lath.			*Rear half.* New Jersey wire lath (⅝ in. stripe) covered by K. W. C. dry mortar.	*Right side.* K. W. C. dry mortar on porous terra cotta lumber.]	*Left side.* K. W. C. dry mortar on porous terra cotta lumber.	*Back.* Lime and hair mortar on wood lath.
	Right. Lime and hair mortar on ¾ in. mesh Clinton wire lath.					*Right side.* K. W. C. dry mortar on Eastern plaster board.	*Left side.* Lime and hair mortar on Eastern plaster board.
	Left. K. W. C. dry mortar on No. 19 Clinton wire lath, ⅜ in. band iron.						

between the two buildings was equal to the width of each compartment.

The interior of each compartment and the ends of the buildings exposed to each other were then treated in a variety of ways with the different materials whose value for fireproofing it was desired to test. The buildings were erected and prepared for their purpose by the parties representing the different materials to be tested; and the fireproofing materials were applied in a thorough and workmanlike manner. Each division or cell had a floor area approximately 4 ft. × 8 ft., and was about 8 ft. in height. Each had an opening about 18 ins. square in the roof to serve as a ventilator, and a door 2 ft. wide by 5 ft. high in the front. These doors were covered on one side only with tin and were hung on unprotected wooden jambs; the result used in that on being exposed to the heat of the fire and making the test they soon burst into flame and fell from their hinges.

In the ventilator in each roof were suspended by wires four pieces of metal, having melting points varying from 450° to 1,680° Fahr., and it was hoped by means of these to determine, at least approximately, how great a degree of heat was developed in each cell at various times during the test. This result, however, was only partially attained, as the point at which the pieces of metal were placed was difficult of observation after the fire in each cell had attained a considerable headway; but the fact was ascertained that in each cell except No. 7, all the pieces of metal were melted, and in No. 7 a piece of metal whose melting point was over 1,200° Fahr., was changed to the fluid state.

In order to make the test a severe one, a large amount of dry cordwood cut into 2-ft. lengths was provided, and this was piled into each cell and into the space between the two buildings until there was a loose heap about 3 ft. high in each cell and a somewhat larger pile in the intervening space.

These piles were wet with a small amount of kerosene, and a pile of excelsior was put under the front of each pile to act as kindling.

The eight fires were started within a few seconds of the same time and soon produced a powerful heat, which was continued for over two hours, during which time a crowd of interested spectators watched the resistance of the different materials to the flame which rushed against them. The details of the tests were in charge of Mr. C. J. H. Woodbury, Vice-President of the Boston Manufacturers, Mutual Fire Insurance Co., and Mr. C. M. Goddard, Secretary of the New England Insurance Exchange. Every effort was made to have the fires in each section produce as nearly as possible the same amount of heat. Besides the above, Messrs. Edward Atkinson, Bartlett, Kent, Freeman and Toppan, of the Mill Mutual Insurance companies, Messrs. Fitch, Murphy and Innes, Fire Commissioners of Boston, Messrs. Shepley, Wheelwright, Rutan and other prominent architects, and a large number of gentlemen interested in the production of fire proof building materials were present during the tests.

As to the comparative value of the different materials shown, it is difficult to give a fair estimate. The building stood on a piece of wet ground, and the moisture which penetrated the walls from this source apparently turned to steam, and forced off from the wall material otherwise entirely uninjured. It is possible that this steam also protected some parts of the building from taking fire. It was evident, of course, that the walls which were made of material entirely incombustible, like terra-cotta lumber and plaster board, had a great advantage over those made of wooden plank. The heat developed in the cells generated sufficient gas from these wooden partitions to force its way through minute holes or cracks in the protecting material, and this gas, igniting at the fire, carried back the flame to the inclosed material, which was thus rapidly consumed.

There can be no doubt, however, that the use of any of the different materials tested would add considerably to the fire resisting qualities of a building, as in no case did the material in any cell show signs of failure in less than an hour from the time when the eight fires were all giving large amounts of heat directly against the walls thus protected, and in most cases no fire was communicated to the protected materials in less than an hour and a half.

It must be confessed, however, that the conditions usually met with in the large majority of buildings in this country would have been more nearly reproduced if some of the partitions had been constructed of studs on to which wooden or wire lath should be nailed. Thus a hollow space would be formed through which drafts could be carried to aid in combustion. The disadvantages of this method of construction would then have been more fully shown, and the value of the different materials as fire resistants under ordinary conditions would have been more fully developed. If we can have solid walls and floors of any materials now used for building, we shall have far less loss by fire than will result from the present system of hollow divisions, even though the material of which they are built is protected on the outside with substances having considerable fire resisting qualities.

Boston Rapid Transit.

The report of Mr. Desmond FitzGerald, M. Am. Soc. C. E., who was sent to Europe as a special commissioner to study and report upon foreign systems, has been submitted to the Rapid Transit Commission of Boston. An abstract of this report is as follows:

Mr. FitzGerald first discusses the horse railways and omnibus lines of Great Britain, and says there are about 1,000 separate lines, of which 400 are double track. They represent a capital of over £15,000,000, and carried in 1890 over 350,000,000 of passengers; the North Metropolitan alone carried about 36,000,000 of these. The net receipts, after all expenses, were about £500,000, thus yielding an average percentage on the capital invested of about 3%. By a table of traffic on the eight largest street railways he shows that the average rate of fare does not exceed 3 cents per passenger, though the fare varies from 2 to 8 cts. according to the distance run, the maximum being 8 miles. The tendency is to steadily decrease the fares; the minimum rate being 6 cts. in 1881, where it is now 2 cts. The lower rates have largely increased travel.

In speaking of the well regulated omnibus traffic on the Strand and other crowded thoroughfares he refers to the strict order maintained and the infrequency of blockades. From the books of Inspector Wells, of the police force, Mr. Fitz Gerald obtained the following figures for travel on the Strand: By actual count, there passed a given point on the Strand, between 2 and 3 P. M., April 12, 1890, 835 cabs, 264 omnibuses (of a capacity of 26 persons each), 753 vans, 12 two-horse carts, 43 carriages, 15 one-horse carts and 18 trucks, a total of 1,340 vehicles of all kinds. From 6 A. M. to 12 midnight 14,637 vehicles passed the same point, and in addition to this there were 84,812 foot passengers. The cheap cab transport of London, Paris and Berlin is briefly referred to.

In discussing underground systems the London Metropolitan and Metropolitan District railways are first taken. These corporations operate about 60 miles of double track roads, with stations about half a mile apart. Their main dependence for traffic is upon suburban connections and with trunk railway lines. The short distance traveler prefers the omnibus and penny fares. The actual service of the road is one train every 5 minutes, capable of carrying 350 to 400 passengers. The average fare per passenger, in 1890, did not exceed 4½ cts., as they are obliged to run 2 ct. fares in the heart of London to compete with the omnibuses. The result is that the District road is about $200,000 behindhand every year. What they lose by omnibus competition is shown by the fact that during the omnibus strike of last year their receipts increased $20,000 per week. Mr. FitzGerald, in traveling over these roads, did not find as much smoke as he expected, because the engines burn smokeless coal or consume their own smoke. In addition to this, numerous open spaces afford some ventilation. The cost of the double track underground tunnel varied from $3,000,000 to $4,500,000 per mile. It is not a paying concern, notwithstanding the fact that it carries 120,000,000 passengers yearly. A bill has passed Parliament authorizing the construction of the Central London electric railway, which will cut the circle in two and provide better transit. This road would be 7 miles long, and the estimated cost is $2,500,000 per mile, including equipment and land damages. The tunnel would be 11½ ft. diameter, and the stations would be provided with hydraulic elevators of a capacity of 100 persons each. Its engineer is Mr. James H. Greathead.

The City & South London Railway, upon which the Central London is modeled, is 3½ miles long, and passes under the Thames. Mr. Fitz Gerald, in speaking of this line, says each train has 3 cars capable of seating 32 people each, one train every 6 minutes. The fare is 4 cts., and the time, including 6 stops, is 15 minutes, or about 15 miles per hour. The noise is like "the roaring of the ocean after a storm," and Mr. FitzGerald says that a headache was the result of each of his six trips through it. The hydraulic elevators at the stations have a capacity of 70 persons. The tunnel is 10½ ft. in diameter. The ventilation is all produced by the train, propelling the air before it. The temperature is between 50° and 55°.

While the road was originally built for a cable the motive power is electricity in a conductor laid between the rails. In addition to the main conductor there is a working, or naked conductor from which the locomotive draws its supply. This latter conductor is a steel rail resting on glass insulators placed on the cross ties. The system is a direct current system with low tension.

The Mersey tunnel at Liverpool is 1½ miles long, and cost $1,000,000 per mile. There are really three tunnels—one, 26 ft. wide and 19 ft. high, carries two railway tracks; under this is a water tunnel, and next an air tunnel, 7 ft. in diameter, which runs along the main tunnel and is connected in the center by shafts controlled by slides. At either end of the tunnel are immense engines, which pump water from the tunnel and draw air, through the center shaft and air passage, from the main tunnel. It is one of the most perfectly ventilated of railway tunnels.

Paris has no rapid transit worthy of the name, and the only feature that Mr. FitzGerald saw worthy of commendation was the stopping of omnibuses and tram cars at regular stations. The belt steam line around Paris is 15½ miles long and connects all trunk lines, but is too circuitous to be of value. Berlin has solved the rapid transit problem for that city with an elevated road.

In concluding his report Mr. Fitz Gerald refers again to the City & South London electric underground railway, and says that, while he was rather predisposed in its favor, the oftener he rode over it the less favorably it impressed him as a system for Boston. It was very noisy; the cars had to be tightly closed to avoid the powerful draft, and were consequently badly ventilated, and he thought the temperature would be too low in the tunnel, in Boston, for the comfort of delicate persons who had to pass out into a summer temperature among the nineties. In these particulars the other underground roads of London were better than the new tunnel. He commends the elevated system of Berlin above all he had seen, for perfection of workmanship and because it is in the sunshine.

Mechanical Appliances for Canal Construction.*

Magnitude of Work.—The Manchester Ship Canal is the largest work of its class in this country; and the mechanical appliances used in its construction have been on the largest possible scale, in order to minimize the employment of labor and to hasten the completion of the work. The number of men and boys employed on the canal has never exceeded 17,000; and about 200 horses have been used. As the excavation amounts to 46¼ million cu. yds., of which over 10 million are sandstone rock, it is clear that any available number of men and horses would be insufficient to do the work in any reasonable time. Ninety-seven steam excavators and eight steam dredgers of large power have therefore been employed. The spoil excavated has in most cases had to be taken several miles to the spoil grounds, the position of which has necessarily been selected where land was moderate in price. For this work and for the general purposes of construction 173 locomotives and 6,300 trucks and wagons have been used.

Railway.—A railway has been laid along the whole course of the canal, in many places on both sides, with numerous sidings. These lines, with those laid in the bed of the canal for excavating purposes, amount to a length of 228 miles of single line. Flat-bottomed steel rails, 56 lbs. to the yard, with fish joints, are laid on ordinary cross timber sleepers. The cost was about £630 per mile of single line. The railway and its rolling stock are on a

* By Mr. E. Leader Williams, Engineer-in-Chief. Paper read before the Institution of Mechanical Engineers at Liverpool. We are indebted to London *Engineering* for cuts.

larger scale than some of the passenger and goods lines worked in this country and on the continent.

Rate of Excavation.—The rate of excavation has varied from ¾ million to 1¼ million cu. yds. per month. As the work proceeded and the cuttings became deeper and the inclines steeper, and as the sandstone rock required blasting before the excavators could remove it, the rate of excavation in the bottom of the canal was slower. The wagons are hauled out of the bottom of the cuttings by locomotive power, the gradients adopted being generally 1 in 30. Steam cranes were largely used in rock cuttings and for setting the masonry. There are employed on the works 121 steam cranes, 192 portable and other steam engines and 212 steam pumps of various sizes, some being large Cornish pumps that had been brought from the Severn Tunnel works. The large plant used consumed about 10,000 tons of coal per month.

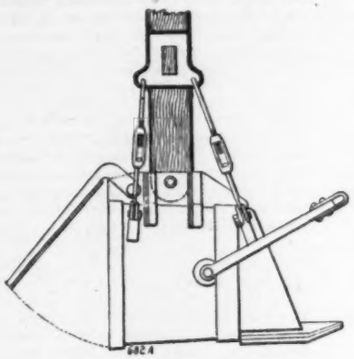


FIG. 1.

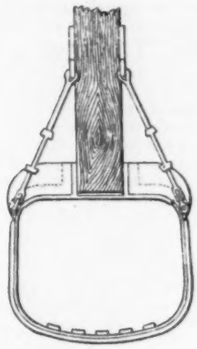


FIG. 2.

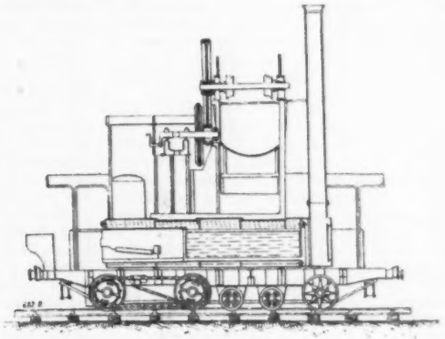


FIG. 3.

Preparation.—As soon as the late Mr. T. A. Walker had got possession of the land as the contractor, he showed great energy in commencing to erect huts, hospitals and chapels for the workmen; and much honor is due to him and his agents and engineers, not only for the way in which the work has been pushed forward, but also for the care taken for the comfort and welfare of the men. The greater part of the plant was specially constructed for the work; the remainder was principally brought from Mr. Walker's contracts at the Severn Tunnel, and Preston and Barry Dock Works. The total cost amounted to £943,610; the whole plant, huts, &c., are the property of the Ship Canal Company.

Excavators.—The steam excavators are of several types, some being land dredgers working with a chain of buckets; also Ruston & Proctor's steam navvies, and Wilson's and Whitaker's steam excavators, which all work a single large bucket, and Priestman's and other grabs.

Ruston and Proctor's Steam Navvy.—No less than 58 of these steam navvies are used, being the largest number ever employed on any work. The machine was fully described in Mr. Ruston's paper at the Lincoln meeting of this Institution in 1885 (Proceedings, page 349). Since then the machinery has been improved and strengthened; and it is now a very perfect excavator for almost every description of soil. Its power in removing hard material is greater than that of any other machine yet constructed; soft sandstone rock is removed by it without blasting, powder being required only in hard rock. The buckets for sand excavation on the canal have been increased in size to hold 2¼ cu. yds. (Figs. 1 and 2), so that two buckets are sufficient to fill a large earth wagon holding 4½ cu. yds. The advantage of this excavator being self propelled is considerable; but its weight is great, and on very soft ground it requires heavy timbers under the rails. It should be put to work if possible, with a high feed, 12 ft. to 15 ft., depending on the nature of the soil; and it will clear its own road, and also that required for the line of earth wagons. The cost is about £1200. With this machine about 2,000 cu. yds. have been excavated in one day of 10 hours in good material. A fair average, however, may be considered to be 600 to 700 cu. yds. per day of 10 hours. The working expenses of a steam navvy may be put at about 30 s. per day. Its disadvantages are that its capability is limited to cutting its way forward only; and that its great weight has sometimes caused its disuse on the canal works, where the ground has been very soft; no ordinary system of rails and sleepers is sufficient to carry the navvy on very soft ground. The fact that these steam navvies can work in hard material is a great advantage, and they have been used in cuttings where no other excavating machine would work.

Wilson's Excavator.—The Wilson steam excavator is of the same type as Ruston & Proctor's. It is made by the firm of Messrs. John H. Wilson & Co., of Liverpool, and has done good work on the canal. It is comparatively light, and therefore easily moved; it can perform a complete revolution round its center, and therefore can work either way, cut out corners, dress slopes, &c., in a better manner than the ordinary steam navvy. Its average work may be taken at 600 cu. yds. per day of 10 hours; occasionally it has largely exceeded this quantity when working in favorable soil. The cost is about £1,050; and the working expenses may be taken at about 25s. per day.

Whitakers' Excavator.—Another of the jib and bucket type of steam excavators used on the works is constructed by Messrs. Whitaker Bros., of Horsforth, near Leeds. It is similar in most of its details to the Wilson excavator, but its cost does not exceed £800; the working expenses may be taken at 25s. per day, and the average work done at 400 cu. yds. per day of 10 hours.

Grabs.—The Priestman and other grabs have been used principally for excavating foundations and other similar work. In suitable soil it has been found to work up to an average of 300 cu. yds. per day of 10 hours. The difficulty of getting this class of machine to enter hard or dense ground militates much against its use on large works. Its special advantage consists in its working under water from a higher level.

The Wilson, Whitaker, and Priestman excavators have one great advantage over others. They are reasonably light, and the steam cranes that work them are available for general work when the buckets or grabs are removed.

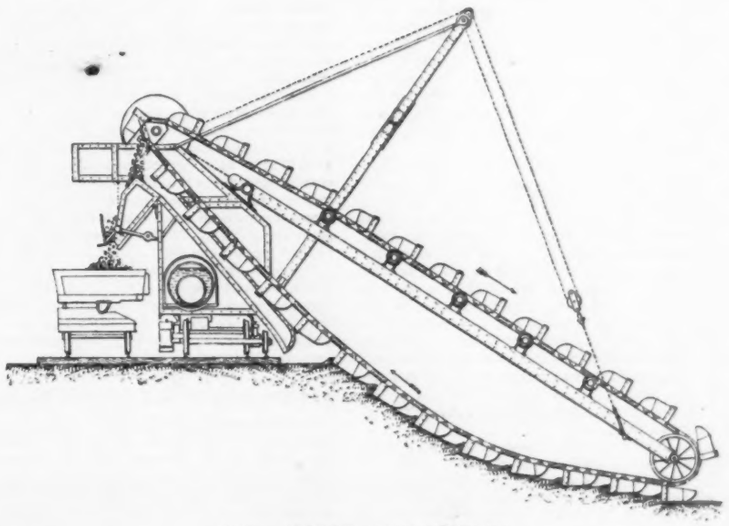


FIG. 4.—FRENCH LAND DREDGER.

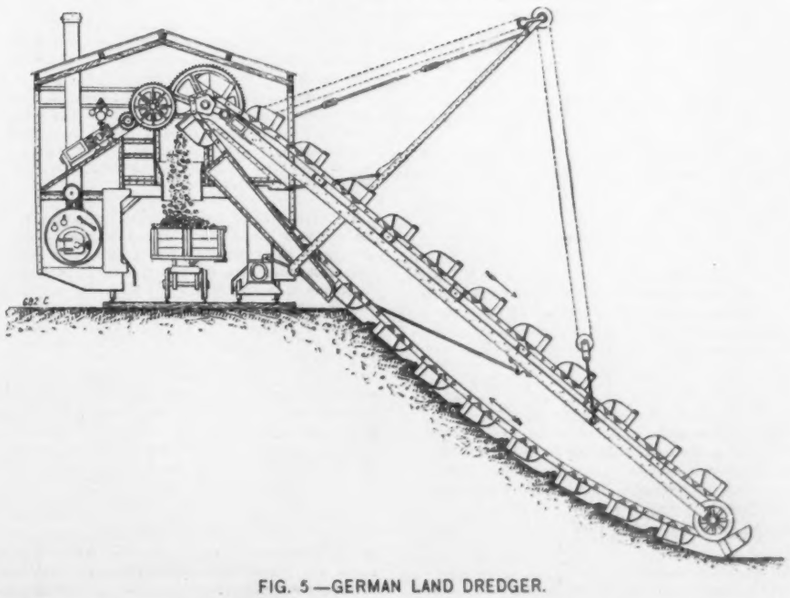


FIG. 5.—GERMAN LAND DREDGER.

French and German Land Dredgers.—In addition to the foregoing machines, four excavators, constructed by Messrs. J. Boulet & Co., of Paris, have been employed (Figs. 3 and 4), and three somewhat similar ones made at Lubeck. On the canal works the three latter are known as the "German" and the four others as the "Frenchman" excavators. These seven machines are of the bucket-ladder kind; they are indeed land dredgers, differing from the floating dredger in the fact that the cutting edge of the buckets, when in the act of cutting, is always toward the machine, that is, the bucket cuts inwards; whereas in the floating dredger the cutting edge is always turned away from the machine at the moment of cutting.

The first cost of the "Frenchman" is about £2,400; and under favorable circumstances it is competent to remove a great amount of material. The best day's performances that are recorded in its favor are as follows: Section No. 3, 1,943 cu. yds.; No. 5, 1,624; No. 7, 2,250; No. 8, 2,025 cu. yds. These are remarkable figures: but the soil and other circumstances must be suitable in order to afford such results. The average day's work on all the districts is about 1,500 cu. yds. If 440 wagons, containing 1,650 cu-yds., were filled per day on section No. 8 by the "French man," it was considered a fair day's work. A bonus of a penny per cubic yard was paid to the men on everything above this quantity. For the excavation of this quantity of material the average daily expenses of the machine in coal, stores and repairs, the last item being heavy, were about 60s. per day, or 0.48d. per cubic yard excavated. There were employed upon the excavator an engine driver and a stoker, and round it a number of men varying from 28 to 43, the average number being 35; the roads required frequent moving. A special locomotive is required in attendance upon the excavator, for though it is traversed by its own power over the train of wagons it is filling, its movement is not sufficiently rapid. The wagons are also kept in motion in the opposite direction by the attendant locomotive.

A great disadvantage in the use of these land dredgers is their necessarily great weight, amounting to at least 80 tons; they consequently entail a heavy and expensive road, which must be maintained if they are to travel at all. They travel on steel rails weighing 80 lbs. per yard, carried by cross sleepers spaced 2 ft. apart. When the ground is at all soft, these cross sleepers are again carried on longitudinals. There is nevertheless a constant danger of the machine upsetting into the cutting, as has actually happened once or twice when working in the light marsh clays. On the other hand there is a decided advantage in the fact that the excavator delivers the spoil at a level of 5 ft. or 6 ft. above the surface of the ground, instead of merely at that height above the bottom of the cutting, thus saving time and power in haulage up inclines from the cuttings.

It is only in certain materials and under special conditions that economical work can be got out of this excavator. The materials with which it is competent to deal satisfactorily are sand, loam, gravel or other light soils. In rock, however soft, it will not work, and hard clays it cannot touch; boulders or imbedded trunks or branches of trees are also found to be insurmountable obstacles. It requires no turning round when it reaches the end of its allotted cutting; it is only necessary to slew the roads, and it cuts its way back to the starting point. It is just as well that this is so, for the taking down of the machine and its re-erection at another site, even though only at the opposite side of the same cutting, is an operation requiring the aid of a large crane and a considerable gang of men.

German Land Dredger.—The land dredger known as the "German" is made by the Lubecker Maschinenbau-Gesellschaft, Lubeck (Fig. 5). The differences between the German and the Frenchman are slight and of minor importance, except in one or two particulars. One point of advantage in the German is the wider base given to the machine, enabling the wagons to pass through its center and receive their load by means of a hopper above, instead of passing over to the back and being loaded through a shoot as in the Frenchman. The wider base is of assistance in throwing the center of gravity further from the edge of the slope, and therefore in preserving the stability of the excavator. As a matter of fact the author is not aware of any instance in which a German excavator has been tipped into the cutting. Its traversing power is sufficient to move ahead with speed enough to fill the set of wagons standing underneath it, without their having to be moved: hence the attendant locomotive of the French excavator is unnecessary. The best day's performance on the different sections of the canal are as follows: Section No. 3, 2,073 cu. yds.; No. 4, 1,736; No. 5, 1,725, and No. 6, 2,400 cu. yds. The average day's work is 1,416 cu. yds., with an average number of 36 men. It weighs about 70 tons, being a lighter machine than the Frenchman, and generally less substantially built; its first cost is the same, namely about £2,400. In other respects the observations already made in regard to the Frenchman apply equally to the German.

The heavily timbered roads required for working the German and French land-dredging excavators increase the cost of working, and as the first cost of these machines is heavy, the cost of excavation does not fall much below the rate of steam navvies, which may be taken in average soils to be 2d. per cubic yard, while that of the grabs may be taken at 3d., and that of the land dredging excavators at 1½d. per cubic yard.

One peculiarity of the excavation has been the employment of a large number of side-tip wagons, capable of holding 4½ cu. yds. each.

Summary of Results.—Summarizing the results of experience in the working of land dredgers in England, it may be said that in light material and on level ground they will fill wagons at considerable speed and with economy, and where large excavations of soft material have to be made with rapidity the bucket-dredging system gives the cheapest and best results. But they will not excavate heavy or strong material; they are difficult and expensive to maintain, and therefore cause delay to the work; they require a costly and a heavy road, and special precautions on soft ground to prevent them from tilting over into the cutting; and they are expensive to move from one cutting to another.

Floating Dredgers.—The Ship Canal Co. also owns four powerful steam dredgers. The *Manchester* is a hopper dredger, built by Messrs. W. Simons & Co., of Renfrew, and has double screws at each end of the vessel, so that it can steam either way, thus avoiding the necessity of turning in the canal. It can dredge 800 tons per hour in favorable material. The *Mersey* and *Irwell* dredgers were built by Messrs. Fleming & Ferguson, of Paisley, in the bed of the canal between Manchester and Warrington. They each dredge 400 tons per hour into hopper barges. The Barry dredger also delivers into hopper barges. There are also working on the canal, three other large dredgers hired from Preston, Ayr., Dumbarton, and the Weaver Navigation; besides smaller dredgers, grabs, &c., worked on barges.

Pile Driving.—At Ellesmere Port there is an embankment faced with stone, one mile long, across an enlargement of the estuary. On each side of the foot of this embankment close timber piling is driven consisting of piles 13 in. to 14 in. square and 35 ft. long. Over 13,000 of these piles have been driven through sand without any trouble, by the use of the water-jet principle. Four steam pumps were used, which delivered the water at a pressure of about 30 lbs. per sq. in. through 2-in. india rubber pipes to the pile, where it was attached to a 1¼-in. wrought iron pipe which was put down under water pressure alongside the pile. With this assistance the steam pile engines quickly drove the pile, which without the disturbance caused by the water jets in the sand could not be driven. Steam pile engines are employed on various sections of the work.

The Topographical Survey of St. Louis, Mo.*

A careful topographical survey and an accurate contour map to cover the whole city of St. Louis, with maps on a large scale, showing the streets, alleys, public grounds, water courses, contours, &c., was authorized March 21, 1889, and the field work was begun in June of that year. The purpose of the survey, as stated in the ordinance, is for the perfecting of plans for the drainage of the city, and for use in locating and opening streets and alleys, and in the establishing of grades for streets and public places. The survey is under the supervision of the Sewer Commissioner, Mr. ROBERT E. MCMATH, and in direct charge of Mr. B. H. COLBY, First Assistant Engineer. The force authorized by the ordinance is as follows, viz.: one first assistant engineer in charge, one precise level man, one topographer, one draftsman, three recorders and as many field hands as are necessary. The work of the survey may be divided into four heads: Triangulation, Precise Levels, Topography and Office Work.

TRIANGULATION.

The area covered by the triangulation is now about 30 sq. miles. About one half of the stations are marked by limestone monuments 6 × 6 × 36 ins., set in the ground. The remainder are on the roofs of buildings. The stations are so distributed that they are on the average less than a mile apart, but the average length of the sides of the triangles is about 1½ miles. The system is based on a line in the trans-continental triangulation of the United States Coast Survey. The line is from a point on the old stand-pipe to the tip of the dome of the Insane Asylum. The latitude and longitude of these two points, with the length and azimuth of the line joining them, were taken from the Coast Survey reports. The average closure of triangles has been a little over 4 ins. The angles of each triangle were summed, and the deficiency or excess from 180° was divided among the three angles before computing the sides. No other adjustment has been made, or thought necessary. Several checks have have been made upon length of sides, and discrepancies have been from 1 in 80,000 to 1 in 180,000. It is expected that an ordinance will be passed requiring that all surveys of streets and subdivisions be connected with the triangulation, and that the true azimuth of all lines be recorded.

PRECISE LEVELS.

Benches have been established on an average four to a mile along the lines run. No point in the district covered is more than one half mile from a precise bench. There have been 361 benches established, and the distance run, in duplicate is about 92.5 miles. These benches are to be the standard for all of the departments and for all elevations in the city. For the convenience of the other departments and of engineers and surveyors in general, a list of the benches with their description and elevations is published. The greater part of the benches are on the stone foundation of bridges and buildings, but in parts of the city where such marks could not be had, a burnt tile slab, 4 × 18 × 18 ins., with a copper bolt leaded into the center, was buried to a depth of 4 ft. The point is accessible through a tile pipe specially made for the purpose.

The limit of error allowed is 0.0 08 ft. into the square root of the distance in miles. The average closure per mile has been 0.013 ft. The probable error in the determination of a single mile of the work is 0.001 ft. If the work lay in a continuous line, the elevation of the last bench, as determined from the first, would be known within a probable error of 0.066 ft.

TOPOGRAPHY.

The stadia has been employed as the best and most rapid method of locating points and obtaining their elevation. By this method 300 points may be located in a day. The party is composed of the topographer, one recorder, three stadia-men, and one general utility man. The instrument used is a complete Buff & Berger transit, reading horizontal angles to 10″ and vertical angles to 1′. The stadia boards used are 12 ft. long, and represent a distance of 458 metres, or the value of 100 metres is 2.62 ft. on the board. The figures used on the stadia are similar to those used on the U. S. Lake Survey. Distances are read in metres, and elevations are obtained in feet by means of Ockerson & Teeple's tables. Oak stakes 1 × 1 × 10 ins. are used for stadia stations, and are driven nearly flush with the ground.

All lines of stadia courses begin and end on triangulation stations, or other stadia stations which are in connecting lines. Both verniers are read to 10″ on all stadia courses. In this way the azimuth is repeatedly checked in the field, and data obtained by which the location of the stations may be checked when the co-ordinates are computed. The error of closure after making the known corrections for inclination and graduation of rods, is about 1 in 800. The average error of closure of azimuth is about 1′ 5″ for each line run, or 11″ per station. All azimuth readings are with reference to the true meridian.

Elevations are carried by means of distance and vertical angle. The height of instrument is carefully measured with a rod (graduated for the purpose), the middle wire is brought to the corresponding point on the board, and the level on the vertical circle is brought to the center of the tube before the angle is read. It is remarkable with what accuracy elevations may be carried when these precautions are taken and care is exercised to keep the instrument in adjustment. The average error of elevations is less than 0.2 ft. per mile.

The notes are kept in well-bound books, 5 × 8 ins. in size, made especially for the survey. They contain 100 double pages, and have the heading of the columns printed on every page, as shown below:

LEFT-HAND PAGE.

Object.	Distance	Vernier A.	Vernier B.	Vertical angle.

RIGHT HAND PAGE

Difference of elevation.	Elevation.	Remarks.

The last column is used for descriptions of bench marks, corner stones, stadia stations, &c., or for sketches.

The area covered (up to the present time) by the topography is 14,933 acres, or 23⅓ sq. miles. The elevations of 54,500 points have been determined, or an average of 3.65 points per acre.

The time occupied in field work is as follows: Triangulation, 62 days; precise levels, 114 days; topography, 248 days: total, 424 days.

OFFICE WORK.

The office work consists in reducing the field notes and plotting. The latitude and longitude of all triangulation stations are determined to hundredths of a second, and also their linear distance from the two nearest minutes of latitude and longitude. The azimuth, and length of the sides of the triangles are computed.

The rectangular co-ordinates of all the stadia stations with reference to the nearest 20″ of latitude and longitude, are computed, adjusted and recorded in a book for that purpose. This is an important part of the work, as by this means the error of closure is systematically adjusted, and checks the location of the stations before the plotting is done. The plotting is done on heavy mounted egg-shell paper, cut into charts antiquarian size. The charts are projected by the polyconic method. The tables based on the development of the Clarke spheroid, published in the report of the Coast and Geodetic Survey for 1881, are employed. The scale is 1 in 2,400.

The charts have the parallels and meridians for every 20″ of latitude and longitude on them, and triangu-

* By Oliver W. Connet, Asst. Engr. Abstracted from the *Technograph* (Univ. Ill.).

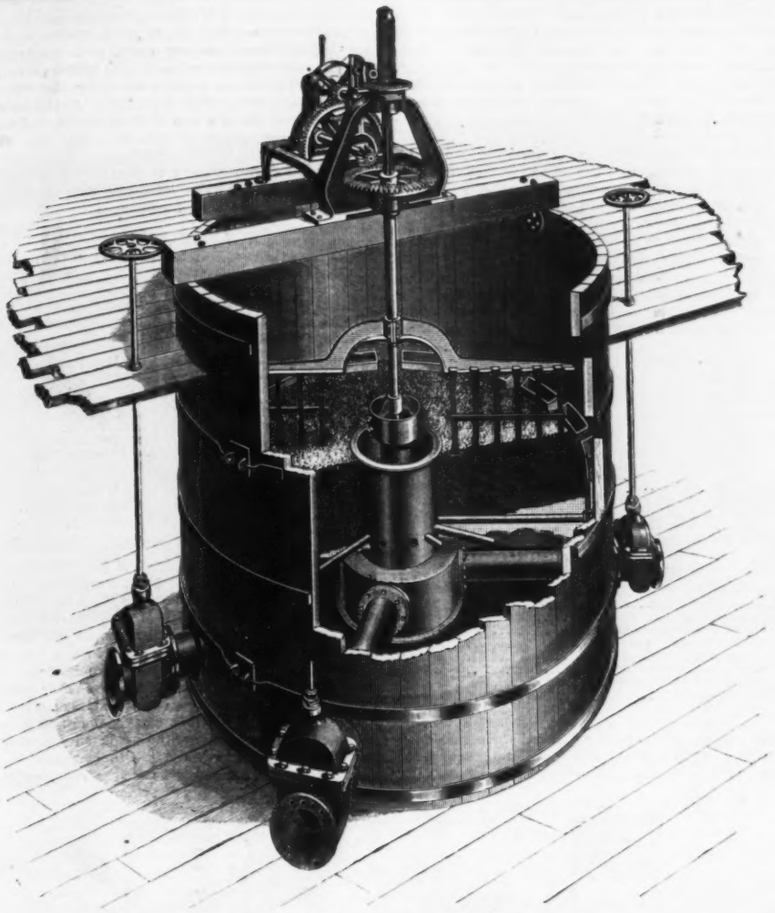


FIG. 1. THE WARREN WATER FILTER.

the upper part of the tank and then downward through the gravel filter and the perforated plate supporting it to the valve on the left leading to the filtered water main. When it becomes necessary to cleanse the filter bed the two lower valves referred to are closed and the valve to the right is opened, allowing the water in the tank to pass to the sewer. When the water has been drawn off the toothed agitator is set in motion, and, by means of a screw, shown at the top of the shaft, this rake is drawn into the bed of gravel. A slight amount of filtered water is allowed to enter from the filtered water main and flow upward through the agitated material; this action rinses away the dirt scoured up by the revolving agitator. When the flow of water becomes clear the agitator is raised and the valves again arranged as before and filtering is resumed.

When the water requires it a coagulant is used, and the process of distributing this coagulant is one of the strong claims of the Warren filter system. What this is can best be explained by describing the Warren filter plant at the mills of Hollingsworth & Vose, finished in November, 1889, and having a capacity of 1,000,000 galls. daily. The water utilized here is taken from the Neponset River and it is very bad, being contaminated by sewage and the waste from a wool-scouring establishment and the Walpole Chemical Works. The water from the river is first taken to a settling basin of rectangular form, the current into which is deflected by a light wooden partition so as to effect an even distribution. The basin is so arranged that sediment can be blown off through specially constructed outlets.

Above this settling basin is the coagulating apparatus, occupying a small space at the end of the basin, which latter is floored and housed over. This apparatus consists of two tanks, in one of which is a concentrated solution of alum, in which the process is hastened by steam, and this solution is automatically proportioned with a strict ratio between the water and the alum supply. From this tank the solution is drawn into the second tank and mixed with water until of a predominating strength. From this second tank the solution is carried through a ball-cock to a small distributing tank, the ball-cock attachment maintaining the level of the liquid in the pump attached. This pump is so geared as to work automatically, its action being dependent on

lation and stadia stations are plotted by rectangular co-ordinates from them. Other points are plotted by polar co-ordinates. The streets and alleys are plotted by means of connections made on the ground and from data obtained from the street department.

All the points taken are plotted, and their elevations written in small figures on the charts and the contour drawn in. The contour planes are taken 3 ft. apart. The charts are finished in ink. The elevations of the contours names of streets, &c., are to be printed on them by means of a small hand press.

COST.

The exact cost of the survey can not be given until it is completed, but some facts concerning the cost of the work, up to the present time, will be of interest. The total cost of the survey to Feb. 1, 1891, is $18,828. This includes salaries, new instruments, office furniture, transportation, &c. Deducting $1,928 for the value of instruments, &c., on hand, leaves a balance of $16,900 as the actual cost of the survey. The cost of the different branches of the work has been as follows:

Triangulation	$1,812	or 11%
Precise levels	2,762	or 16%
Topography	6,060	or 36%
Office work	6,266	or 37%
Total	$16,900	100%

The cost of running precise levels has been $30 per mile, run in duplicate. The average cost of the parties, per day, including transportation, instruments, &c., is as follows:

Triangulation	$29.25
Precise levels	24.25
Topography	21.50

The average total cost per square mile is $721.50, or a little over $1.13 per acre.

The New Warren Filter.

The cuts given herewith show the latest development of the Warren water filter as invented by Mr. JOHN E. WARREN and originally applied at the Cumberland Mills of S. D. Warren & Co., with a capacity of 12,000,000 galls. of filtered water in 24 hours.

In operation, the unfiltered water enters at the valve shown at the base of Fig. 1, and passes into

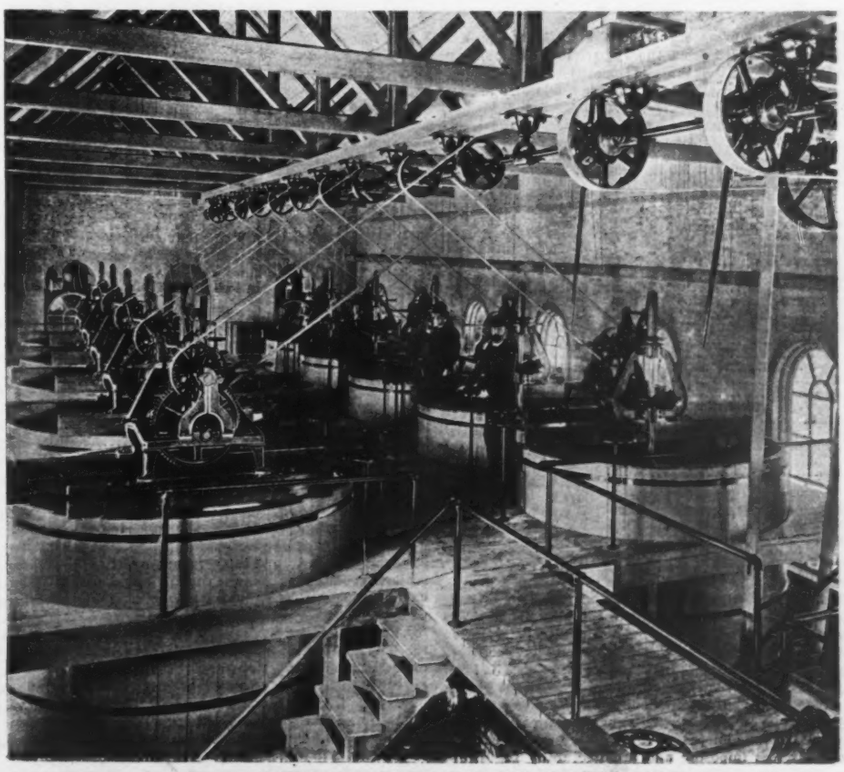


FIG. 2. WARREN WATER FILTER PLANT AT OSKOSH, WIS.

the flow of the water to the filters, and the amount of coagulating solution in the filter is thus automatically regulated and delivered by the pump at the inlet of the basin. After receiving this chemical treatment the water flows to the filter, through it and through 20 ins. of gravel to the reservoir for use. The result is that, at these mills, the water in the reservoir, 9 ft. deep, is perfectly bright and clear.

Fig. 2 in our illustrations shows the plant of 10 Warren filters recently erected at Oshkosh, Wis., which havr a capacity of 2,000,000 galls. in 24 hours. Mr. W. C. MAXCY, the president of the water company, says that in the "worst days" this plant has pumped and delivered to consumers and for fire purposes 1,800,000 galls. daily without drawing on the storage capacity.

Any further particulars regarding this filter can be obtained from the Cumberland Man. Co., of 220 Devonshire St., Boston, Mass. The claim is made that this is the only filter having a mechanical appliance for cleaning the gravel bed, and that as used at the Cumberland Mills, first referred to, it is applied to the largest mechanical water filtering plant in existence.

Electrical Subways at the World's Fair, Chicago.

The illustration given, for which we are indebted to *The Electrical Engineer*, shows a proposed subway disposal of electric wires for the World's Fair, at Chicago. As now planned, the conductors, after leaving the dynamos, will be arranged in a suitable fireproof rack located under the main floor of the Machinery Building, and running lengthwise of the building 150 ft. from the south wall. From this rack five distinct groups of feeding wires will conduct the power to as many centers of distribution and use.

The tunnels or subways for taking off these wires will be of sufficient capacity, each to accommodate 160 insulated cables or wires up to 600,000 circular mills area. Some of these subways will be 3 ft. wide only, and contain but one rack. The cross arms will be of iron, provided with holes for taking the insulators, and special arms will be used when necessity requires it. Other forms of subways are being discussed, but it is said that the arrangement for supporting the conductors and the dimensions, as here shown, will be adhered to.

World's Fair Figures.

The status and prospects of the World's Columbian Exposition, as received from the Department of Publicity and Promotion of the World's Exposition, are indicated by the following data, brought up to Oct. 15, 1891, and presented as concisely as possible:

EXPOSITION BUILDINGS.

Buildings.	Dimensions in feet.	Area in acres.	Cost.
Mines and Mining	350 × 700	5.6	$260,000
Manufactures and Liberal Arts	787 × 1,687	30.5	1,000,000
Horticulture	250 × 1,000	5.8	300,000
Electricity	545 × 700	5.5	375,000
Woman's	200 × 400	1.8	120,000
Transportation	250 × 900	5.5	280,000
Admini-tration	260 × 260	1.6	450,000
Fish and Fisheries	163 × 363	1.4	200,000
Annexes (2)	135 diameter	.8	
Agriculture	500 × 800	9.2	540,000
Annex	328 × 500	3.8	200,000
Assembly hall, &c.	450 × 500	5.2	
Machinery	500 × 800	9.8	1,200,000
Annex	490 × 551	6.2	
Power-house	80 × 600	1.1	
Fine Arts	320 × 500	3.7	500,000
Annexes (2)	120 × 200	1.1	
Forestry	200 × 500	2.3	100,000
Saw Mill	125 × 300	.9	35,000
Dairy	95 × 200	.5	30,000
Live Stock (3)	53 × 330	1.3	150,000
" sheds		40.0	
Casino	175 × 300	1.2	*150,000
		144.8	$5,800,000
U. S. Government	350 × 420	3.4	400,000
Battleship	348 × 69.25	.2	100,000
Illinois State	160 × 450	1.7	250,000
		150.1	$6,640,000

* Including cost of pier.

The last three are being erected, the first two by the United States Government and the third by the state of Illinois. The visitor, however, will naturally class them among the great Exposition structures. It has been decided that the annexes to the Fine Arts Palace shall be larger than indicated above, but the changes in the plans are not yet made. It is now believed that owing to the great demands for space more annexes than are named above will be found necessary. All of these annexes will be scarcely less imposing and architecturally beautiful than the main buildings themselves. The live stock sheds, which will cover an immense area as indicated, are to be constructed as inexpensively as possible without marring the general architectural effect. There will be several exposition buildings in addition to those named, but the plans for them are not yet completed. Among them will be a music building and a press building. The total cost of the exposition structures is estimated by the Grounds and Buildings Committee at $7,295,000.

It cannot be stated yet how many state buildings and buildings of foreign nations there will be in Jackson Park, but it is safe to say that the whole number will be fully 75. These, particularly those of foreign nations, will show a great diversity of architecture.

Special features, such as the "Street in Cairo," "Bazar of All Nations," "Street in Constantinople," &c., will be located on Midway Plaisance. This is a strip of land more than a mile long, embracing 80 acres and connecting Jackson Park with Washington Park. The boulevard traversing its center will be lined on both sides with these special features.

The exposition company has very large expenditures to meet in addition to the cost of the buildings. In fact, the latter does not constitute one-half of the total amount necessary to carry through the exposition enterprise. In a recent report made by the Grounds and Buildings Committee, the following estimates of such expenses were given:

Grading, filling, &c	$450,000
Landscape gardening	323,490
Viaducts and bridges	125,000
Piers	70,000
Waterway improvements	225,000
Railways	500,000
Steam plant	800,000
Electricity	1,500,000
Statuary on buildings	100,000
Vases, lamps and posts	50,000
Seating	8,000
Water supply, sewerage, &c	600,000
Improvement of lake front	200,000
World's congress auxiliary	200,000
Construction department expenses	520,000
Organization and administration	3,308,563
Operating expenses	1,550,000
	$10,530,053

Adding to this the amount estimated to be necessary for buildings ($7,295,000), and the grand total sum to be expended by the exposition company, stands at $17,825,053. All of the great buildings have been contracted for and are under construction. On several the work is proceeding night and day, and all are being pushed to completion by large forces of workmen. Insurance is placed and increased on the buildings as their construction proceeds. It is the intention to carry insurance aggregating $300,000,000 on the buildings and exhibits.

In view of the showing given above, a statement of the Exposition's finances is interesting in this connection.

RESOURCES.

Stock subscriptions	$5,608,110
City of Chicago bonds	5,000,000
Prospective gate receipts	10,000,000
Concessions and privileges	1,500,000
Salvage	1,000,000
Interest on deposits	27,035
	$23,135,145

To the resources will be added future interest on bank deposits, and future subscriptions to stock. Subscriptions are coming in daily, and the amount which will thus be realized is certain to be large, though how much it will be cannot, of course, be estimated now even approximately. Of the subscriptions already received 60% has been called for, and considerably more than $3,000,000 has been paid in. The number of subscribers is over 30,000. Death, impoverishment, &c., have caused thus far a delinquency in collections of between 7 and 8% of the whole amount due. This is much less than was anticipated. Quite a number of subscribers have anticipated the calls and have paid up in full. The $5,000,000 from city bonds is certain to be realized in full, as Chicago's credit is excellent. The gate receipts, concessions and privileges and salvage are necessarily prospective, and the amounts given are of course estimates. It is believed they are moderate. As a large share of the resources, as given above, cannot be realized until the exposition opens, it is naturally the desire to anticipate a portion of them in some way in order to meet the heavy expense attending the erection of buildings and preparation of grounds. Accordingly it is contemplated asking a loan of $5,000,000 of the Government, pledging the gate receipts as security for its payment.

The total disbursements to Oct. 15, for all purposes, have been $1,459,089. The estimated total expenses to be borne by the exposition company are:

Grounds and buildings	$13,966,495
Organization and administration	3,308,563
Operation expenses, May to November, 1893	1,550,000
	$17,825,053

Appropriations for their representation at the exposition have been made by the states and territories of the Union as follows:

Arizona	$30,000	New Hampshire	$25,000
California	300,000	New Jersey	20,000
Colorado	100,000	New Mexico	25,000
Delaware	10,000	North Carolina	25,000
Idaho	20,000	North Dakota	25,000
Illinois	800,000	Ohio	100,000
Indiana	75,000	Pennsylvania	300,000
Iowa	50,000	Rhode Island	25,000
Maine	40,000	Vermont	15,000
Massachusetts	75,000	Washington	100,000
Michigan	100,000	West Virginia	40,000
Minnesota	50,000	Wisconsin	65,000
Missouri	150,000	Wyoming	30,000
Montana	50,000		
Nebraska	50,000	Total	$2,695,000

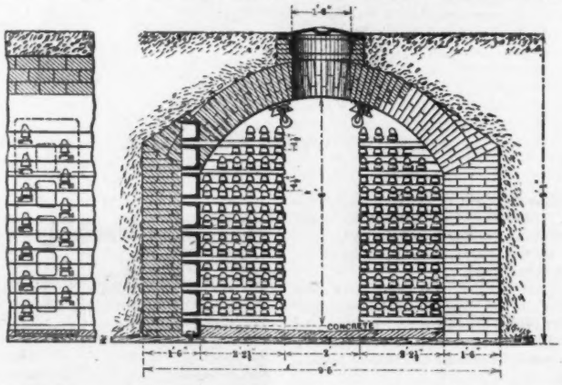
Within a few months nearly all of the other states will be added to this list. In 6 or 7 the legislatures will meet this winter for the first time since the exposition enterprise assumed definite shape. Most of them will unquestionably make liberal appropriations, as popular sentiment demands it. It is certain, too, that a number of states, which have already made appropriations, will increase them. In 9 states which made no Fair appropriations, either because of constitutional restriction or by reason of political bickerings, state conventions have been held, and plans, generally of the stock subscription sort, have been inaugurated and are in operation to raise amounts deemed necessary for proper representation at the exposition. These states and the sums they are endeavoring to raise are:

Alabama	$100,000	Oregon	$100,000
Arkansas	100,000	South Dakota	80,000
Florida	100,000	Tennessee	50,000
Georgia	100,000	Texas	300,000
Kansas	100,000		
Total			$1,030,000

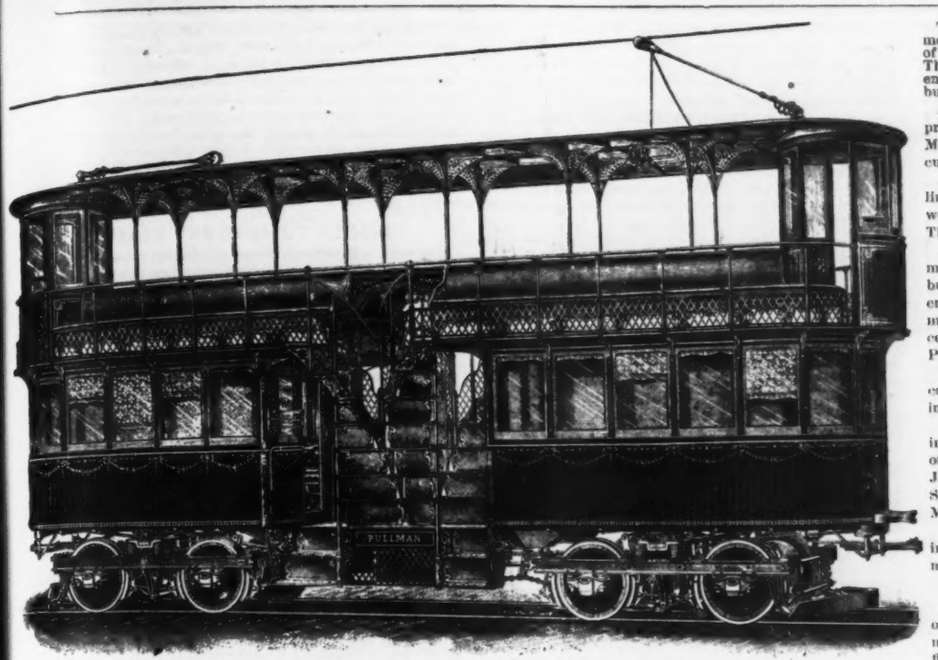
The expenditure by the states and territories, it is reasonable to believe, will aggregate more than $4,000,000.

The foreign nations and colonies which have formally determined to participate in the Exposition, and the amounts of their appropriations made or officially proposed, as far as information concerning them has been received at headquarters, are the following:

Argentine Republic	$100,000
Austria-Hungary	168,000
Belgium	
Bolivia	150,000
Brazil	445,000
China	
Chili	100,000
Colombia	100,000
Costa Rica	50,000
Denmark	
Danish West Indies	10,000
Ecuador	125,000
France	400,000
Algeria	
Germany	250,000
Great Britain	125,000
British Columbia	
" Guiana	15,000
" Honduras	7,000
Cape Colony	10,000
Jamaica	
New South Wales	
New Zealand	
Trinidad	10,000
Guatemala	120,000



PROPOSED ELECTRICAL SUBWAY AT THE WORLD'S COLUMBIAN EXPOSITION.



PULLMAN CENTER VESTIBULE DOUBLE DECK CAR.

Hayti	
Honduras	20,000
Japan	500,000
Mexico	750,000
Netherlands	
Dutch Guiana	
" West Indies	
Nicaragua	20,000
Persia	
Peru	100,000
Russia	
San Salvador	30,000
San Domingo	
Siam	
Spain	
Cuba	25,000
Porto Rico	
Turkey	
Uruguay	
Venezuela	
Zanzibar	

This partial list foots up 31 nations and 14 colonies, and appropriations aggregating $3,630,000. The United States Government has appropriated thus far $1,500,000, of which $400,000 is available for its building alone. Another appropriation is sure to be made at the next session of Congress.

The Pullman Center-Vestibule Double Deck Electric Car.

As one of the most notable new departures in the design and arrangement of street cars we give herewith a view of the Pullman double-deck car, the tests, proportions and general construction of which we have described in our two preceding issues. The West End Electric Ry. Co., of Boston, has already ordered four of these cars, we may note, and it will doubtless come into quite extensive use on many electric long-trip lines.

Repeating in part what we have already stated in regard to this new type, we may note that the car is sheathed outside with narrow strips, like an ordinary passenger car. The inside finish is mahogany, with decorated quartered-oak ceiling. The glass in the windows is crystal sheet, while that in the doors is French plate, embossed. Mirrors are placed on the upper deck and on each side of the doors, and the car is provided with spring seats and backs, covered with tapestry. The car has two cabs, each equipped with a seat. The wheels are Allen 30-in. The motive power is furnished by two Westinghouse single reduction motors, of 25 HP. each, one motor on each truck, to which trap doors in the floor give direct access.

The extreme dimensions of the car are 32 ft. × 7 ft. 4 ins. × 14 ft. 9½ ins. high; seating capacity 40 per deck; total capacity perhaps 160 with all standing room taken. Two Burton electric heaters are used in each of the lower compartments, and electric bells are substituted for the usual bell cord. An electric indicator diagram show below what seats are vacant on the upper deck. The total weight of the empty car is 28,000 lbs., and its total cost, $3,500, is said to be some $20 per seat less than for ordinary horse cars. The Pullman Palace Car Co. is said to be enlarging its street car shops with the especial end of obtaining better facilities for their construction.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Dutchess County.—About 300 men are now at work on this New York road and the force is being constantly increased. Track has been laid for 1¼ miles north of Hopewell Junction and will soon be completed to Fishkill Plains. After this the men will be transferred to the Poughkeepsie end. It is expected to have the road finished by Dec. 1. Steel rails weighing 70 lbs. per yd. are being used. The road will be operated by the New York & New England R. R. Co., when completed.

Pittsburg, Shenango & Lake Erie.—About ½ mile of track has been laid on the branch of this railway to Conneaut Harbor, O., and both tracklaying and grading are making rapid progress.

Bristol.—Over three miles of track has been laid on this railway from New Haven to Bristol, Vt.

Housatonic.—It is stated that this company will double track the Ridgefield Branch and extend it to a connection with the New York Central & Hudson River R. R at Brewster's, N. Y.

Wabash.—The right of way has all been secured for the Chicago extension of this railway, but no construction will probably be done until next spring.

Delaware & Otsego.—At a recent meeting of the directors of this company it was stated that the prospects were good for the early extension of this road from Bloomville to Oneonta, N. Y. The extension will cost $125,000, and of this amount $100,000 in capital stock have been subscribed. The Ulster & Delaware R. R. Co., will lease the road when completed.

Philadelphia & Reading.—The grading and masonry on the Tamaqua, Hazleton & Northern R. R. will be completed about Nov. 1.

Lake Shore & Michigan Southern.—Three miles of the Silver Creek & Dunkirk R. R. cut-off have been completed and it is expected to have the entire nine miles finished by next spring.

Concord & Portsmouth.—This company will double track its line from Portsmouth to Greenland, N. H.

Boston & Maine.—The engineers of this company are surveying the proposed Canaan & Oxford R. R. connecting the Passumpsic with the Northern railway.

Iron Range & Huron Bay.—Mr. Sanford Keeler, superintendent, has offered the contract for completing the construction to J. Lally, of Detroit. Chief Engineer Milo Davis has resigned, and C. D. Miller, of Chicago, has taken his place.

Chicago & West Michigan.—Surveys are in progress from Sparta, Mich., northeast, and are expected to result in a branch to Howard City. A mile of track a day is being laid on the Petoskey extension.

Projects and Surveys.

Madison & Lexington.—A press dispatch from Madison, Ind., says:

Two important meetings of capitalists and business men were held in this city Oct. 23 and 24, in the interest of a projected railway from Madison to Lexington, Ky. The Indianapolis Board of Trade has taken hold of the enterprise and there is little doubt that the road will be built.

Providence & Ponaganselt.—A second survey of this proposed railway from Providence, R. I., to Springfield, Mass., has been completed and a very favorable line secured.

Navesink.—Chartered in New Jersey, Oct. 8, to build a line of railway. Among the incorporators are J. R. Maxwell, Brooklyn, N. Y., and B. H. Wyckoff, Elizabeth, N. J. The capital stock is $300,000.

Southern Central.—It is stated that work will be commenced upon the construction of this road, from Harrisburg to Shamokin, Pa., 55 miles, about Dec. 1. The engineers are now at work completing the surveys and making estimates. The company was chartered in December, 1890, and its president is C. W. McKeehan, of Philadelphia, Pa.

Salem-Washingtonville.—Bids have been received for constructing the proposed railway from Salem to Washingtonville, O.

Chicago, Indianapolis & Chattanooga.—Chartered in Indiana by F. L. Patrick, of Columbus, O., D. P. Erwin, of Indianapolis, and others. Length, 150 miles, via Marion, Johnson, Brown, Monroe, Lawrence, Orange, Dubois and Spencer counties. Surveyors are reported at work near Mitchell, Ind.

Middletown & Odessa.—A short railway is to be built in Delaware between these towns, a distance of about four miles, to run along the highway.

SOUTHERN.—Existing Roads.

Atlantic Coast Line.—About 500 men are now grading on the branch to Washington, N. C., and the work is making good progress. It is expected to have the line finished by Jan. 1, 1892.

Norfolk & Western.—The *Manufacturers' Record* publishes an interview with President Kimball of the Norfolk & Western R.R., who has just returned from Europe, where he was in the interest of the road. President Kimball says:

"Work on all the extensions of the road will be pushed forward with greater vigor than ever. By Dec. 1, 60 miles of track on the Ohio extension will be completed to the bridge now being built across the Ohio River, and regular trains will be running to Columbus. I expect to have the entire Ohio extension completed by next July, which will open up the whole West to the celebrated Pocahontas coke and coal. The business of the road is growing so rapidly and so many new industries are springing up along the line that the managers find it almost impossible to keep pace with the phenomenal increase in business. Cars are in great demand, and it is difficult to provide them fast enough for the traffic."

Raleigh Springs.—The contract for building this Tennessee railway has been let to Dan. Harvey, of Memphis, Tenn., the work to be completed in 60 days. Contracts for the cross-ties and bridge material are now being let. Eugene S. Lynch, Memphis, Tenn., Chief Engineer.

Ohio River.—The difficulties about securing terminals at Hopkinsville, Ky., for the extension from Princeton to that place have all been settled and the contract for building the line has been let. Work will begin all along the line at once.

Projects and Surveys.

Louisville, Cumberland Gap & Atlantic.—The surveys for the section of this railway from Johnson City, Tenn., to Elizabethton, Tenn., have been completed and a very favorable line secured. The maximum curvature will not exceed 4° and the maximum grade will be about 60 ft. per mile. Surveys are now in progress for the section from Johnson City to Cumberland Gap, Tenn.

Oxford & Coast Line.—W. S. Beasley was elected President and R. W. Rossiter, Jr., Secretary, at a meeting of the stockholders at Oxford, N. C., Oct. 23. Surveys of the line have begun.

Mobile, Jackson & Kansas City.—It is reported that the engineers who have been examining the proposed route of this railway from Mobile, Ala., to Jackson, Miss., in the interest of English capitalists, will report favorably upon the scheme.

Brunswick Western & Southern.—The Wilmington & Southern R. R. has been purchased by Chicago capitalists and reorganized under the above name. The officers are: President, George L. Dunlap; Vice-President, Frank Ullery; Secretary and Treasurer, Geo. H. Bliss, all of Chicago, and General Manager, H. H. Dougherty, of Newark, N. J. Surveys will be commenced under the direction of the General Manager at once, and it is expected to have the section from Wilmington to Southport, N. C., completed by April, 1892.

Bryan & Taylor.—Surveys will soon begin under the direction of Chief Engineer C. W. Murray, Fort Plain, Ga., for the proposed railway from Taylor to Bryan, Ga., 8 miles. Jas. Taylor is building the line.

Cannonsburg & State Line.—Work is reported begun on the proposed railway connecting Wheeling, W. Va., and Pittsburg, Pa., via Cannonsburg, W. Va. The road has been contemplated for several years, but nothing but a little surveying has yet been done.

NORTHWEST.—Existing Roads.

Northern Pacific.—Thomas Oleson, of Spokane, has a contract for 3 miles near Algoma and 9 miles near Grantiteville. The work includes one 440-ft. tunnel.

Chicago & Northwestern.—Kimball & McNamara have secured a contract for 15 miles of double tracking between Waukegan and Kenosha.

Duluth & Winnipeg.—R. B. Deal, of Duluth, has a contract for several timber bridges on this road.

St. Louis & Hannibal Short Line.—Contracts are to be let at once for the branch to Perry, about 18 miles in length. Geo. B. Clason, Hannibal, Mo., is General Manager.

Great Northern.—Surveys are in progress for an extension from Park Rapids to Fosston, Minn.

Pacific Short Line.—This railway has been sold to Geo. W. Wickersham and A. S. Garretson, as trustees, for $2,000,000. The claims against the road amount to about $325,000.

Minneapolis, St. Paul & Sault Ste. Marie.—The branch from Hankinson to Valley City, N. Dak., 81 miles, has been completed. About 10 miles of track has been laid on the line from Boynton to Bismarck.

Projects and Surveys.

Sioux City, Madison & Northern.—An official of this road is reported as saying that the promoters were pushing the preliminary work and that the company would soon be ready to commence actual work.

SOUTHWEST.—Existing Roads.

San Antonio & Aransas Pass.—A compromise has been reached in the controversy between Gurly, Ross & Gurly, the contractors, and the receivers of this road, and tracklaying has been completed on the Waco branch.

Houston, Central Arkansas & Northern.—Track laying has been commenced on this line between Riverton and Alexandria, La., 75 miles, and it is expected to have the work completed this season.

Velasco Terminal.—Rapid progress is being made upon this line from Velasco to Chenango, Tex., 57 miles, and it is expected to have the road in operation by Nov. 15. Rails weighing 67 lbs. per yard are being used.

Consolidated Terminal.—An extension of the Kansas City Suburban Belt line is being built under this name. President A. E. Stillwell has raised nearly half a million dollars to carry on the work.

Interoceanic.—An official of this company, recently chartered in Arkansas, in a recent interview is reported as saying:

We are working in unison with the Choctaw Coal and Ry. Co. and other interests and already have 160 miles of railway constructed. Twenty miles from Fort Reno, Ind. Ter., east are completed. We have men with money behind us and will build the road. The Kansas & Texas Coal Co., the Choctaw Coal and Ry. Co., and the Little Rock & Memphis Ry. Co. interests will be harmonized.

Projects and Surveys.

Springfield, Sedalia, Marshall & Northern.—The engineers have completed the survey of this road from Springfield, Mo., to Miami, Mo. The average grade is 50 ft. per mile.

Marshall, San Augustine & Sabine Pass.—The preliminary survey of this railway from Jasper to Carthage, Mo., has been completed. The President of the company is W. A. Fletcher, of Beaumont, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

Valley.—A correspondent writes us as follows:

Two miles of this railway are already completed and the remainder will be built during the coming season. It is projected to run from Helena, Mont., northwest to the Missouri River, at a point to be called Harlow, a distance of 15 miles. All surveys have been completed and the right of way practically all secured. The maximum grade will be 2% and the curves will run from 4° to 8°. The principal business will be in ores, wood and passengers. Richard A. Harlow, of Helena, Mont., is President and W. A. Haven is Chief Engineer.

Seattle & Northern.—It is stated that the money necessary to extend this road to Sauk City, Wash., has been raised.

Northern Pacific.—The Anacortes & Skagit Branch will be extended to a connection with the Washington Central R. R. in the Big Bend country. The bonds to provide money for building the extension have been floated and construction will begin at once. Work on the branch to South Bend, Wash., is making good progress. Ten miles have been completed from South Bend east and 5 miles more will be finished in a few days. Thirty miles from Chenalis, Wash., west will be completed by Nov. 1. This will leave only 11 miles more to be constructed.

Great Northern.—The Seattle & Montana R. R., running from Seattle to the Fairhaven & Southern R. R., 78½ miles, has been completed with the exception of a small amount of ballasting and some work on the terminals at Seattle. It is hoped to have the road in operation by Nov. 15. A press dispatch says:

Surveyors of the Great Northern's Pacific extension have made the important discovery that the main divide of the Rocky Mountains is only 5,200 ft. above the sea level instead of 5,500 ft., as shown in the old maps. Over 5,000 men are now employed grading the track laying, and it is expected there will be no cessation of work this winter. Sixty miles of grade are ready for the track to the west of the present terminus, which will be completed at once. J. J. Kennedy has come in from the extension. The bridge over the Big Rover, he says, is now completed. Track has been laid as far as this point, which is about 25 miles from the summit. West of the Rocky Mountains a surveying party is at work near Buenna, which indicates that the line will hug the shore very closely from that point to Fairhaven.

Projects and Surveys.

Denver & El Paso.—Surveys will soon begin under the direction of Horace G. Ropes for this line from Las Vegas to White Oaks, N. Mex.

Aspen Contract Mining Co.—A contract has been let for constructing a railway from Woody, Colo., near Aspen, Colo., to mines up Woody Creek, to Col. M. Murphy, of Aspen, Colo. Work will be begun at once.

Coos Bay & Oregon Central.—Chartered in Oregon to build a railway from Gold Beach to Drain, Ore. The capital stock is $2,500,000.

Blue Canon Coal.—This company will build a railway from the Blue Cañon coal mine to the water front in the city of Portland, Ore.

Oregon.—The West Coast Construction Co. has been chartered in Oregon to build and equip railways. Capital stock, $500,000.

Hudson, St. Vrain, Erie, Mitchell, Baker, Lafayette, Louisville, Marshall, Denver & Pacific Ry. Co.—A railway company by this name has been chartered in Colorado, to build a railway 40 miles long from Hudson to Marshall, Colo. The incorporators are: James Henshell, S. D. Kara, Wm. McKissick, John Long and Geo. Butterbough. It is to be regretted that the surnames of the incorporators could not have been, in some manner, introduced into the name of the road.

Pueblo, Wet Mt. Valley & Western.—A. E. Graham, of Pueblo, Colo., writes us as follows:

The preliminary survey has been completed for this proposed railway, which is projected to run from Pueblo, Colo., west to Beulah, Red Creek and Silver City, Colo., a distance of 70¾ miles, and arrangements are now being made for locating the line. About 45 miles of the work, 30 miles at the east end and 15 miles at the west end, will be comparatively easy work. The remaining 25 miles will be mountain work and quite difficult; maximum grade 3% and maximum curve 16°. There will be no bridges or tunnels of importance. Nearly all of the right of way has been secured and $75,000 each from Pueblo and Silver City obtained besides considerable other aid from the people along the route. The company is now endeavoring to interest other capital in the enterprise. The principal business of the road will be in silver and lead ores, marble, sandstone and general merchandise. At present about 20,000 tons of minerals are shipped to Pueblo and Cañon City alone. The scheme is now in the hands of a committee of citizens organized to promote the construction of the road. The present officials are: President, J. C. Teller; Chief Engineer, A. N. Welles, both of Denver, Colo.

Siuslaw & Eastern Ry. & Navigation Co.—Mr. T. R. Berry, of Eugene, Ore., Chief Engineer of this company, sends us the following account of its affairs:

The line of this road has been located from Siuslaw Harbor east to Eugene, and preliminary surveys have been made from Eugene east across the Cascade Mountains. The line follows the postal route from Florence to Eugene, and the Cascade Mountains are crossed by the McKenzie Pass. Beyond this there is nothing definite. The total projected length of the line is about 500 miles. Over the portion of the line surveyed the work is about one quarter rock, with light side-hill cuts. The maximum grade is 1%, and maximum curvature 6°. There will be a bridge of five spans across the Willamette River and one tunnel 2,100 feet long through the Coast Range Mountains. The road will traverse an agricultural region, and will open up some large timber tracts and coal lands. Right of way has been secured for a distance of 76 miles. The only local aid secured is in the form of rights of way and terminal grounds. Funds are provided by the 13 directors of the company. The annual meeting of the company will be held on Dec. 7, and contracts for the construction will be let immediately afterward. The company was chartered Jan. 1, 1890. Mr. Geo. H. Ellsburg is president.

CITY TRANSIT.

Electric Railways.—***Lockport, N. Y.***—The Lockport Electric Motor & Street Ry. Co. will build a line about 8½ miles long

Towson, Md.—The Electric Traction System Co., of Baltimore, has applied for power to construct an electric road on Roland Ave., using an underground conduit system.

Rome, Ga.—The street and dummy railways around the city will be converted into electric lines. The electricity will be generated by water power.

Hammond, Ind.—The Hammond City Ry. Co. will build an electric road to East Chicago.

St. Louis, Mo.—The St. Louis & Suburban Ry. Co. has converted the narrow gage extension of its cable dummy road to an electric system. An electric railway to Clayton is projected by John L. Boland, T. K. Skinker and R. C. Carr. The St. Louis Electric Ry. Co. has applied for a franchise, offering to pay $1,000 per year for 2 years, and $2,000 per year afterward.

St. Paul, Minn.—The street railway company will build an electric road on Front St. to Como Park.

Duluth, Minn.—The Park Point Street Ry. Co. proposes to build a line on Lake Ave. to Superior.

Helena, Mont.—The dummy railway company has been authorized to convert its line to an electric system.

Seattle, Wash.—Mr. Anderson, C. E., has applied to the authorities of King Co. for a franchise for an electric railway 12 miles long to Richmond. L. H. Griffith, H. W. Wheeler, B.F. Shaubut and J.F. Hale are members of the company which has in hand the construction of the electric road to Tacoma, 40 miles. The preliminary survey has been made.

Stockton, Cal.—A 50-years franchise for an electric railway has been granted to Mr. J. A. Lartitt.

Cable Railway.—***Oakland, Cal.***—The Consolidated Piedmont Cable Co. will cable its line to Mountain View Cemetary.

Elevated Railway.—***Chicago, Ill.***—It is reported that the North Chicago Street Ry. Co. now proposes to construct an elevated line to Evanston, for which a franchise will shortly be asked of the City Council. The new line will connect with the terminus of the present cable line at Diversity St. and will run over Evanston Ave. to Evanston and South Evanston, the entire length of the line being about 7 miles.

Companies.—Bates & Blake Electric Railway Conduit Co., of Waterloo, Ill.; J. W. Bates, E. C. Blake and J. J. Caldwell.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Waltham, Mass.***—This city has authorized the appropriation of $10,000 for the construction of a bridge across the river at Elm St.

Attalla, Ala.—Efforts are being made to secure the construction of a bridge across Wills Creek, in Etowah Co. Address J. M. Davidson, Attalla, Ala.

Oakland, Cal.—An iron bridge 100 ft. long, and 80 ft. wide at Fourteenth St. is proposed. Estimates have been made by N. Mariotte, of East Oakland.

Ohio River.—It is reported that a company is being organized to bridge the Ohio River at a point 3½ miles above Evansville, Ind. The shops of the Ohio Valley Ry. will be located at this point.

Duluth, Minn.—The Board of Public Works will advertise for competitive bids, plans and specifications for a drawbridge across the canal. The cost is estimated at $100,000 to $150,000.——The St. Louis River bridge is to be built by a new company, organized in connection with the Duluth, Red Wing & Southern R.R. Piles are to be driven as soon as the ice forms.

Denver, Col.—It is reported that a viaduct about ¾ of a mile long will be built across the railway tracks connecting Highlands Boulevard with Seventh St. Alderman McGilvray is at the head of the scheme.

Tunnel.—***Houston, Tex.***—A tunnel under the Houston & Texas Central tracks, on Third St., will be begun at once.

HIGHWAYS.

Pennsylvania.—The Borough Council of Ambler has awarded the contract for macadamizing Lindenwold Ave. from Butler Ave. to Bethlehem Pike. The roadbed is to be only 16 ft. wide at present, and the stone to be used is from a local quarry. William Burk was the successful bidder. The Orvilla Ave. Turnpike Co. has been incorporated by Abraham Tower and others, of Orvilla.

Tennessee.—In Shelby Co. about 10 miles of new turnpike road have been built and macadamized by convict labor during the summer and fall.

Alabama.—The Jefferson Co. Commissioners have awarded contracts for 20 miles of public roads.

Michigan.—The Board of Supervisors of Muskegon Co. have appointed a committee to consider the question of raising a tax to build gravel roads or aid gravel road companies.

Oregon.—The Big Nestucca Wagon Road Co., of Dolph, Ore., has been organized to maintain toll roads, &c., in Tillamook and Yamhill counties. Mr. O. L. Landingham, $3,000.

Washington.—The Snohomish Co. Commissioners have taken the initiatory steps toward bonding the county for $250,000 for the building of roads. The warrant prescribes roads into the various sections of the county.

WATER-WORKS.

NEW ENGLAND.

Bingham, Me.—A company has been formed and has begun to introduce water from a spring, probably for domestic use only.

Lyndon Centre, Vt.—A supply from a spring about 3,600 ft. from the village is being talked of. Company ownership is mentioned.

St. Albans, Vt.—The sum of $85,000 was voted Oct. 25 for an increased supply, in accordance with recommendations by L. A Taylor, Boston. A large storage reservoir will be built.

Brookline, Mass.—An appropriation of $9,000 has been voted for new mains.

Clinton, Mass.—The water board has been authorized to issue $10,000 of bonds for improvements.

Lowell, Mass.—More experimental wells are being sunk.

Marlboro, Mass.—The Council has voted to issue $30,000, 4%, 30-year water bonds for the expenses and liabilities of the department.

Middleboro, Mass.—The mains are to be extended one-half mile to Chiltonville.

Bridgeport, Conn.—It is reported that a 10,000,000-gall. pump will be put in.

MIDDLE.

Johnsonville, N. Y.—Works are reported as under construction.

Medina, N. Y.—It is reported that the franchise for works will expire on Nov. 1, no work having been done.

East Orange, N. J.—The Orange Water Co. has offered to sell its property in East Orange to the township for $500,000. The present contract expires Jan. 1, 1892, but the company's contract with Bloomfield runs for two years more.

Greensburg, Pa.—The Western Water Co. has been

incorporated by Clifford Stanley Sims, Philadelphia; Murray Forbes, Deny Station; P. W. Janeway, 242 South Third St., Philadelphia, and others, the latter being treasurer; capital stock, $1,000,000.

Montrose, Pa.—Works are still projected.

Radnor, Pa.—William Perot, Jr., H. Bayard Hodge both of Philadelphia, will, it is reported, apply on Nov. 10 for the chartering of the Radnor Water Co.

Washington, D. C.—Capt. J. L. Lusk has recommended the appropriation of $100,000 for a new high service system.

SOUTHERN.

Radford, Va.—H. P. Briggs, Councilman, is offering for sale bonds of the eastern section of the city to establish water-works and electric lights in that section. Part of the city, at least, is now supplied by a company.

Salem, Va.—Surveys are being made by the Development Co. for a supply from the Griffin Spring.

Mannington, W. Va.—The agitation for works still continues.

Buena Vista, Ga.—The city has secured authority to build works

Cedartown, Ga.—Plans for works are being made by Hartford, Hebert & Co., Chattanooga. Bonds have been voted.

La Grange, Ga.—A contract for works has been closed with the American Pipe Co., the works to be completed within 18 months.

Marietta, Ga.—Application has been made by Webster Young, Cortland, N. Y., Sterling Phillips, Marietta, and others for the incorporation of the Marietta Water-Works Co. It is stated that water privileges have been secured and that water would be pumped to the top of Campbell's Hill.

Ozark, Ala.—It is reported that a contract for works has been let.

Natchez, Miss.—A compromise has been made between the conflicting parties, and the works, for some time in the hands of a receiver, will be sold and a new company organized.

New Iberia, La.—Works are projected.

Morristown, Tenn.—It is reported as probable that the Morristown Water-Works Co. will soon begin to build works.

Cloverport, Ky.—The people are trying to secure works.

Ludlow, Ky.—A committee has been appointed to report at a citizens' meeting to be held on Nov. 4 on securing a water supply,

NORTH CENTRAL.

Dayton, O.—Wells are to be added and an additional suction pipe laid.

Cannelton, Ind.—The Council has granted a 25-years' franchise to the American Pipe Co., Philadelphia.

Fort Wayne, Ind.—Plans are being considered for the completion of a reservoir abandoned some time ago on account of accidents during construction.

Muncie, Ind.—The company has offered to extend its mains three miles. No action has been taken by the Council.

L'Anse, Mich.—The following is from S. Kinney:

A conditional contract for building works has been made by the village with G. C. Morgan, Chicago. Supply, creek, by gravity; estimated cost, $15,000. Population, 800.

Romeo, Mich.—All the bids for building works have been rejected. It is stated that nothing further will be done before next spring.

Belleville, Ill.—Preliminary surveys are being made for a supply from Kaskaskia River, 14 miles distant.

Galva, Ill.—It is reported that works will be built.

Quincy, Ill.—Nov. 17 the people will vote on building works. MacRitchie & Nichols, Chicago, have reported on works estimated to cost $620,000. The city is now supplied by a company between which and the city there are disagreements,

Ashland, Wis.—The company's capital stock will be increased.

Superior, Wis.—There is agitation in favor of the purchase by the city of the company's works.

NORTHWESTERN.

Duluth, Minn.—C. B. Davis, Chicago, has reported upon the present condition and valuation of the private gas and water-works now supplying the city. On a revenue basis, capitalized at 5½%, he estimates the value of the works at $1,756,000, not including real estate. The cost of duplicating the present works is estimated at $1,628,000. In case the city buys the works Mr. Davis recommends that the intake be extended to 60 ft. of water, or further, and that other improvements be made. Also that a new source of supply be investigated.

South Saint Paul, Minn.—It is estimated that works could be built, including a supply from artesian wells, for $50,000. Water bonds to the amount of $100,000 were recently voted, but have been declared invalid.

Blue Springs, Neb.—Construction has been started by Contractors Hutson & Shepherd.

Morris, S. Dak.—It is proposed to grant a water and electric lighting franchise to some of the citizens.

Lander, Wyo.—The following has been received:

The town will grant a 20-years franchise for works taking their supply by gravity from the Big Popo-Agie, which flows through the town with a fall of 60 ft. per mile. A pressure of 90 lbs. in Main St. will be required. The town is the seat of Fremont Co. and is 140 miles from the Union Pacific Ry. at Rawlins. Population, 800. F. T. Wright and N. H. Brown are Council Committee on Works and J. E. Hill is City Engineer.

SOUTHWESTERN.

Cape Girardeau, Mo.—It is reported that works will be built.

Kansas City, Mo.—The experts have reported that works capable of supplying 200,000 people can be built for $2,425,629 and that works sufficient for present needs can be built for $2,002,435. Bonds to the amount of $2,000,000 were voted some months ago.

Helena, Ark.—The Helena Water Co. has been incorporated with a full paid-up capital stock of $100,000. The officers are: President, M. P. Hillyer; Secretary, W. M. Neal; Treasurer, T. A. Straws.

Pine Bluff, Ark.—Application has been made for a receiver of the company works in the interest of the bondholders. It is said that improvements will be made if a reorganization is effected.

Stuttgart, Ark.—It is reported that the company desiring to build works is known as the Stuttgart Improvement Co., W. M. Price, Vice-President.

Bonham, Tex.—It is reported that the city is about to contract for works having a daily capacity of 300,000 gall. of water.

Dallas, Tex.—An expert committee consisting of Rudolph Hering, F. Harris and D. A. Poyner, has reported on repairs to the reservoir bank, which recently gave way, and as to the general improvement of the works. The committee consider that the embankment can be repaired by rebuilding the portion where the slide occurred and riprapping the embankment, river bank and bed at an estimated cost of $12,803. The sinking of a dozen 8-in. experimental wells is recommended, as is a reconstruction of parts of the distributing system.

Elgin, Tex.—C. A. King, Mayor, informs us that the city will let a contract about Dec. 1 for works estimated to cost $10,000. The supply will be pumped from wells to standpipe. Population, 1,200.

Fort Worth, Tex.—The time for receiving bids for the new city works has been extended from Oct. 19 to Nov. 15. See ENGINEERING NEWS for Sept. 26.

Henrietta, Tex.—Bids for building works are wanted. Address H. J. Strickfadden, City Secretary.

Guthrie, Ok. T.—J. W. Hamilton has offered to build works for the city for $50,000 in bonds. The supply would be pumped from bored or driven wells to an elevated tank by means of two 750,000-gall. pumps. Six miles of mains and 50 hydrants are proposed.

Raton, N. M.—The following is from L. Kingman, Topeka, Kan.:

The works owned by the railway company is to be transferred to the Raton Water-Works Co. A dam 48 ft. high and 360 ft. long, impounding 52,000,000 galls., is being built. The surface of the reservoir will be 458 ft. above the town. The supply main will consist of two miles of 10 and five miles of 8 in. cast-iron pipe, and will have a daily capacity of 1,000,000 galls.

PACIFIC.

Medical Lake Wash.—In November a vote will be taken on issuing $13,000 of bonds for works.

Pendleton, Ore.—An additionaly supply is talked of.

Portland, Ore.—The Albina Water Co., which supplies the former town of Albina, has contracted to extend a 6-in. main to the Willamette Tract.

Berkeley, Cal.—It is reported that the State University Regents propose to condemn land for a storage reservoir, and that a tunnel will be driven.

Sacramento, Cal.—An experimental well will be sunk with a view of obtaining a supply from wells.

Brigham City, Utah.—Hyram House, of Corrinne, is trying to secure a franchise, or else a contract for building works to be owned by the city.

ARTESIAN WELLS.

Dayton, O.—About 25 additional driven or tubular wells are to be put in near those now in use.

Jacksonville, Fla.—It is reported that a well is to be sunk in the park.

Vicksburg, Miss.—Two wells are to be sunk in the yard of the Louisville, New Orleans & Texas R. R. Co.

Lufkin, Tex.—An effort is being made to secure money for sinking a well.

Nolanville, Tex.—Money is being raised by the citizens to sink another well.

Rogers, Tex.—An artesian well company is being organized.

Garfield, Ore.—Preparations are being made to sink a town well.

IRRIGATION.

Missoula, Mont.—Riddle & Watts have the contract for a 7½ mile ditch 13½ ft. wide at the top. The ditch is for the Cañon Ditch Co.

Buena Vista, Col.—The *Herald* of this place states that surveys of a site for a large reservoir at Cottonwood Lake have been completed by the State Engineers.

Ellensburgh, Wash.—The following is from R. R. Stevens:

Bonds have been voted by the Middle Kittitas Irrigation District for the construction of a canal to take water from the Yakima River. The canal will be 40 miles long, the first 18 miles of which will be heavy work, including a tunnel 800 ft. long. W. P. Mason, Ellensburgh, is Chief Engineer.

Delano, Cal.—The final survey for the Kern and Tulare District canal is being made by J. S. Urton and J. D. Browne.

Otay, Cal.—Progress is reported in the formation of the Otay Irrigation District.

Selma, Cal.—The irrigation board has called an election for Nov. 16, to vote on the issuance of $800,000 of bonds.

Gila Bend, Ariz.—Land has been taken upon the Gila River about 12 miles above this place, and it is proposed to raise water to irrigate it by means of rotary pumps.

New Companies.—Laura Lake Canal Co., Great Falls, Mont., $450,000; J. J. Ellis, Z. L. Burton and others. Oklahoma Ditch and Water Power Co., Guthrie, Ok. T.; $110,000, J. D. Cooke, Toledo, O., C. W. Price, Oklahoma City, Ok. T. Deschuttes Irrigation Co., Prineville, Ore.; $24,000; B. F. Nichols, M. H. Holbert.

SEWERAGE AND MUNICIPAL.

Sewers.—*New Hampshire.*—Rochester. The cost of a complete system is estimated at $125,000 to $150,000, but it is suggested that a system be designed and a certain portion built annually.—Hanover. Surveys are being made for a system of sewers.

Massachusetts.—Newton. The sewers will probably be completed by December; the work is being done by the Sewerage Committee.—Newburyport. A sewer contract has been awarded to J. Cashman by the Sewer Commissioners.

Connecticut.—Meriden. A contract has been made between the Sewer Committee and Mr. C. P. Bassett, and the latter will shortly commence work on surveys for a map and plans of the sewerage system. Mr. T. H. McKenzie will be associated with Mr. Bassett in the work.

New York.—Cortland. The Lewis-Mercer Construction Co. has made a proposition to the Board of Trustees to put in a system of sewers.—Medina. Work on the sewer will be commenced shortly by G. W. Barlow and M. Van Rensselaer, the contractors.—Silver Creek. A sewerage system is projected.

New Jersey.—Orange. The Common Council has not yet awarded the contract for building the main trunk sewer from Orange to the Passaic River, although the bids have been under consideration for some time, and the date has passed when the contractors were to be required to begin on the work according to the conditions of the bid. The delay is due to the fact that Bloomfield and Montclair have not yet fully determined whether they will unite in the use of the trunk sewer. Montclair is willing to do so, but its consent is contingent upon being permitted to lay a connecting sewer through Bloomfield. The latter township wants, in consideration for its consent, the right to join the system at any time without at present assuming any responsibility. Orange does not care to build a larger sewer than is necessary for those places which are to use it.

Pennsylvania.—Harrisburg. A sewer in the Sixth Ward, on Muench St., is proposed.—Williamsport. The contract for sewer pipe has been awarded to the Lock Haven Clay Works Co., of Lock Haven, Pa., and Guise & Jacoby have the contract for construction.—Bellefonte. A system of sewers is proposed. South Scranton. A sewer on the South Side is proposed.—Philadelphia. It is proposed to proceed with the construction of the Wissahickon intercepting sewer.

Kentucky.—Bowling Green. Mr. J. M. Humphrey, of Memphis, Tenn., will report upon a system of sewers. He has been investigating the location in company with the city engineer, Col. Crump.

Georgia.—Cedartown. Plans for the new sewerage system are being prepared by Hartford, Herbert & Co., of Chattanooga, Tenn.

Ohio.—Columbus. The Board of Public Works will advertise for new proposals for the construction of sewers in District 2.

Indiana.—Elkhart. A sewer contract has been awarded to Miller & Mims, of Council Bluffs, Ia.

Arkansas.—Little Rock. Plans are to be prepared for a complete system of sewerage.

Idaho.—Boise City. A contract has been let for a sewerage system to cost $100,000.

Oregon.—Oregon City. An ordinance has been prepared for a system of sewerage and plans have been made by the city engineer.

Washington.—Fairhaven. A petition has been presented for sewerage for North Fairhaven.

Street Work.—*Massachusetts.*—Lowell. It is proposed to extend and widen Dummer St., at a cost of $50,000.

New York.—Rochester. East Ave. has been paved with Canton brick on a concrete foundation.—Dunkirk. The contract for brick paving on E. 4th St. has been awarded to Mr. Rider, the brick to be of the Brady's River Co. or Park Fire Clay Brick Co.'s make.—Buffalo. The Claflin Paving Co., of Cleveland, O., has the contract for block paving on Seneca St., for $61,000.

Pennsylvania.—Philadelphia. Mr. Smedley has had two plans prepared for the proposed boulevard from the City Hall to the Park. Both show sidewalks 25 ft. wide, with green areas in front of the house and a clear space

of 15 ft. to the curb. One has a space wide enough for car tracks and a carriage to right and left of a single broad driveway, with trees on either side. In the other the middle space is divided by a bicycle path. The former is preferred. The Highway Committee has approved Mr. Windrim's estimate of about $1,100,000 for 1892.——Erie. Brick paving is proposed for 17th St.

North Carolina.—Salisbury. A contract of street work amounting to about $25,000 has been awarded to N. B. & J. C. McCandless.

Florida.—Jacksonville. Brick paving is suggested.

Michigan.—Detroit. The National Paving & Construction Co., of Adrian, is putting down cement sidewalks.

Indiana.—Indianapolis. It is proposed to pave West Washington St. with brick, and Massachusetts Ave. with asphalt.—Richmond. An order for 40,000 brick for Fort Wayne Ave. has been given to the Canton Brick Co., of Canton, O.

Illinois.—East St. Louis. Elco gravel is to be laid on some streets.——Alton. Brick paving is being laid.——Jacksonville. A contract for Berea sandstone sidewalk has been awarded to J. Silva, of Springfield, at $18,000.

Wisconsin.—Ashland. About $500,000 will be spent on streets and parks. Paving contracts have been let amounting to $22,000.

Missouri.—St. Louis. The proposed boulevard system aggregates nearly 52 miles.

California.—Oakland. Plans have been prepared by Mr. Geo. F. Allardt for the West Oakland park improvement and Lake Merrill boulevard.——Alameda. Artificial stone sidewalks are to be laid.——Santa Barbara. The City Council has adopted plans for a boulevard 100 ft. wide, extending about one mile along the beach in front of the city, just above the high water mark, and protected from the sea by a heavy bulkhead. The sidewalk and roadway will be paved with bituminous rock and lined with double rows of trees. An extension 25 ft. wide will cross Castle Rock to the beach beyond, and an extension 40 ft. wid will extend east of State St. a mile and a half to the Montecito beach. The work will cost about $100,000.

Manitoba.—Winnipeg. The city engineer has presented estimates as follows for cedar block and macadam paving:

	Cedar block.	Macadam.
Smith St	$11,000	$8,500
Logan St	13,530	10,000
Assiniboine St	5,000	.....
Jarvis and Dufferin Sts	24,000	18,000
Garry St	7,500	6,000
Notre Dame St	13,500	10,000
Total	$74,500	$52,500

Bonds.—Oakland. Cal.; $400,000 for West Oakland Park, $400,000 for Lake Merrill Boulevard. Beaumont, Tex.; $30,000 for streets and sewers, $6,000 for water-works extension. Kansas City, Mo.; $175,000 for completing O. K Creek sewer to Turkey Creek. Columbus, Ga.; $175,000 for sewers; vote to be taken Jan. 16. Iosco County, Mich.; $5,000 for reclaiming 25,000 acres of swamp. Newburyport, Mass.; $15,000 for sewer debt. Toledo, O.; $80,000 for street improvements. Nashville, Tenn.; $75,000 for sewers. Dayton, O.; $198,000 for paving, sold to Blake Bros., of Boston, Mass., for $211,970.

ELECTRICAL.

Electric Light.—*Wakefield, Mass.*—Municipal ownership is not recommended, as the city would have to purchase the plant of the Wakefield Electric Co.

Cambridge, N. Y.—A contract for 500 incandescent lights has been awarded to Bernard & Co., of Troy, N. Y.

Allegheny, Pa.—There is public opposition to the proposal to increase the city debt $100,000 for electric lighting.

Vicksburg, Miss.—Proposals for electric lighting will be received by the Mayor Dec. 17.

Norwalk, O.—The contract for lighting the streets for 5 years has been awarded to the Incandescent Light & Power Co. at $58 and $62.50 per light for 1 o'clock and all night lighting.

Mascoutah, Ill.—The city has passed an ordinance contracting with the Mascoutah Electric Light Co., and the plant will be in operation by December.

Milwaukee, Wis.—A resolution has been referred to the Street Lighting Committee, directing the Board of Public Works to enter into a 5 years' contract with the Badger Illuminating Co. for the use of the Thomson-Houston patents of the electric lighting upon the present terms of $112.50 per light per year.

Kirksville, Mo.—It is proposed to issue $38,000 in bonds for electric lighting.

Seattle, Wash.—It is proposed to spend $30,000 on an electric light plant.

Companies.—Crouch-Houston Electrical & Mfg. Co., of Eugene, Ore.; to manufacture the Crouch safety dynamo; F. J. Crouch, of Eugene; $1,000,000. New York Electric Construction Co., of Jersey City, N. J.; John H. Hapgood, P. B. Vermilyea and Geo. E. Hutchinson; $100,000. Union County Electric Co., Roselle, N. J.; H. P. Baldwin, of Roselle; H. M. Byllesby, of St. Paul, Minn.; W. H. Moore, Plainfield, N. J.; $30,000.

CONTRACTING.

Bridges and Approaches.—*New York, N. Y.*—The total bid of the Pennsylvania Steel Co. for the Macombs Dam bridge, the detail list of bids for which was given last week, was $915,536, and not $885,536. The company's bid was the third from the lowest and not next to the highest.

Pipe.—*Milwaukee, Wis.*—The contract for 1,000 tons of cast-iron water pipe has been awarded to Dennis Long & Co., of Louisville, Ky., at $24.94 per ton.

Canal.—The following proposals have been received by Gen. O. M. Poe, U. S. Engineer Office, Detroit, Mich., for 10 gate anchorages for the new 800-ft. lock of the Sault Ste. Marie Canal; King Iron Bridge & Mfg. Co., Cleveland, O., 5 cts. per lb. for wrought steel, 3 cts. per lb. for cast iron; total, $20,447. Walker Mfg. Co., Cleveland, O., 6.1 cts., 2½ cts., $21,129. Keystone Bridge Co., Chicago, Ill., 6.36 cts., 3 cts., $22,336. Phœnix Iron Co., Trenton, N. J., 6.9 cts., 2.2 cts., $23,475. Russell Wheel & Foundry Co., Detroit, Mich., 7.2 cts., 2.83 cts., $25,589. W. F. Hopkins, St. Louis, Mo., 7.9 cts., 2.97 cts., $26,474. Passaic Rolling Mill Co., Paterson, N. J., 6¼ cts., 4¼ cts., $28,614 Dry Dock Engine Works, Detroit, Mich., 8¼ cts., 3¼ cts. $28,666. Williard S. Pope, Detroit, Mich., 10¾ cts., 3¼ cts., $32,345.

Removal of Wreck.—The following proposals for removing the wreck of a schooner in Hyannis Harbor, Mass., have been received by Major Livermore, U. S. Engineer Office, Newport, R. I.: Charles W. Johnston, Lewes, Del., $935; Enoch Townsend, Somer's Point, N. J., $1,645; William E. Chapman, New York, N. Y., $1,800, George W. Townsend, Boston, Mass., $2,091; Hiram W. Phillips, Quincy Point, Mass., $3,000.

Dumping Apparatus.—The contracts for the James River dumping apparatus at Richmond, Va., have been awarded as follows by Col. Wm. P. Craighill, U. S. Engineer Office, Baltimore, Md., Railway track and transfer slip, C. D. Laughorne, Richmond, Va., $8,350; caisson, H. T. Morrison & Co., Petersburg, Va., $2,476; car, Tredegar Co., Richmond, Va., $325.

Bridges—The contracts for two bridges have been awarded by Mr. Maxwell, State Engineer of Colorado: Grand River bridge at De Beque, Missouri Valley Bridge Co., $12,490. Bear River bridge, at Craig, Wrought Iron Bridge Co., of Canton, O., $4,445.

PROPOSALS OPEN.

Sewer Pipe.—*Winnipeg, Man.*—About 18,000 ft. of 9 to 21-in. vitrified pipe. D. Smith, Chairman of Committee on Works. Nov. 12.

Buildings—*Chicago, Ill.*—Illinois building for the World's Fair. Architects, W. W. Boyington & Co., 157 La Salle St. J. P. Reynolds, Director-in-Chief, Illinois Board of World's Fair Commissioners, Montauk Building. Nov. 18.

Ukiah, Cal.—Jail and sheriff's office. The County Clerk of Mendocino County. Jan. 4.

Lighting.—*Vicksburg, Miss.*—Electricity or gas. R. V. Booth, mayor. Dec. 7.

Mattoon, Ill.—Lighting with arc lights of 2,000 c. p. on an area of about 1¼ sq. miles (1,000 acres). Frank Kern, mayor. Nov. 7.

Bridge.—*Kansas City, Mo.*—Iron bridge, 100-ft. span. F. J. O'Flaherty, County Surveyor. Nov. 9.

Paving.—*St. Louis, Mo.*—Wood block paving on bridge. Board of Public Improvements. Nov. 10.

Elevators.—Three passenger elevators, one mail elevator and one ash elevator, all hydraulic; with pumps, tanks, cars, &c., for the U. S. building at Pittsburg, Pa. W. J. Edbrooke, Supervising Architect, Treasury Department, Washington, D. C. Nov. 19.

Highway.—*Groton, Conn.*—Macadamizing 2½ miles from Groton to Eastern Point. The Road Committee.

Bridge and Culvert.—Lift bridge over the Erie Canal at Rowe St., Rochester, N. Y.; Nov. 9. Culvert under the Erie Canal at Adams Basin; Nov. 5. Edward Hannan, Superintendent of Public Works, Albany N. Y.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., will build a four-cylinder Vauclain compound engine for the Pike's Peak rack railway. The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered 2 of 4 ten-wheel compound engines for the Southern Pacific. The Brooks Locomotive Works, of Dunkirk, N. Y., are building 12 moguls for the Lake Erie & Western. The Rogers Locomotive Works, of Paterson, N. J., have built two Jull snow plows, for the Chicago, Burlington & Quincy and Chicago & Northwestern. The Cooke Locomotive Works, of Paterson, N. J., have an order from the Chicago, St. Paul & Kansas City. The shops of the Grant Locomotive Works, of Chicago, Ill., are progressing. The Lake Shore & Michigan Southern is getting bids on 30 engines.

Cars.—The Harvey Steel Car Co., of Chicago, Ill., has built a number of grain cars for the Chicago, Milwaukee & St. Paul. The Michigan Car Co., of Detroit, Mich., has an order for 600 gondola cars and 150 box cars for the Pennsylvania; they will have Janney couplers and the box cars will have automatic brakes. The St. Charles Car Co., of St. Charles, Mo., has an order for 300 coal cars of 60,000 lbs. capacity for the Texas & Pacific. The Canda Mfg. Co. will build car works at Carteret, N. J. The Chicago, Milwaukee & St. Paul has ordered 40 vestibuled cars; it is building its own freight cars. The Delaware Lackawanna & Western R. R. has added 2,000 freight cars to its equipment. The Gilbert Car Mfg. Co., of Troy, N.Y., has an order for 10 electric cars for the State St. line, Albany, N. Y.

Street Car Heating.—The Toronto Street Ry. Co., of Toronto, Ont., has given an order to the McClary Mfg. Co for equipping the cars with the McClary stove.

Electric Elevator.—The Edison Electric Illuminating Co., of Brooklyn, N. Y., has equipped its passenger elevator with the method of controlling electric motors brought out by H. Ward Leonard & Co., of New York. The arrangement is said to give absolute control of the car and to require very little attention. As the current on the motor is constant, whatever the speed may be, the neutral point is fixed and the brushes require no adjustment to prevent them from sparking. The motor operates continuously at its highest efficiency and there is no likelihood of the armature burning out, due to sudden changes of load. It is possible to instantly reverse the car and motor at any speed without strain, while the motion under all conditions is similar to that of a hydraulic elevator.

The Berlin Iron Bridge Co., of East Berlin, Conn., has designed and will build the new iron boiler house for the Oswego Pulp & Paper Co., at Fulton, N. Y.

The Aerated Fuel Co., of Springfield, Mass., states that it has begun suits in the U. S. Circuit Court for the District of New Jersey, against a firm in that state, for making and selling apparatus infringing its patents, and against two glass manufacturing companies for using such apparatus. The company claims that its patents cover the whole system of burning oil with compressed air, automatically regulated, and considers any other oil burner to be used with compressed air as an infringement of its rights.

The Joseph Dixon Crucible Co., of Jersey City, N. J., states that the *Moniteur Industrielle* recommends the use of a mixture of oil and graphite on all screws in machinery, as it will prevent them from becoming fixed and protect them from rust. The company has for some years prepared graphite mixtures which have found great favor with machinists and steamfitters. Dixon's graphite pipe joint mixture is said to be very much better than red lead, while Dixon's graphited oil is used where a thinner mixture is desired, and also for lubricating bearings.

Companies.—Acme Railway Signal & Mfg. Co., of Galesburg, Ill.; $50,000. Belmor Smokeless Steam Generator Co., of San Francisco, Ill.; George E. Belmor, George L. Anderson and S. C. Parker; $500,000. Puget Sound Iron Co., of Seattle, Wash.; $1,000,000. New York Frog & Switch Co., of Hoboken, N. J.; J. L. Nevin, A. A. Franck and M. P. Merseles, of Jersey City, N. J.; $100,000. Eagle Iron & Steel Co., of Ironton, O.; $100,000. Granite Concrete Co., of Chicago, Ill.; granite-concrete roadways, sidewalks, &c.; $1,000. Lewis Valve Gear Co., of East St. Louis, Ill.; W. J. Lewis, L. B. Fisk and E. S. Marshall; $600,000. Pneumatic Supply Co., of San Francisco, Cal.; Thomas Trebell, M. M. O'Shaughnessy and C. C. Morehouse; $500,000.

Metal Market Prices.—*Rails.*—New York: $30; old rails, $21 for iron and $16.50 to $17 for steel; girder rails $40. Pittsburg: $30; old rails, $23.50 to $24 for iron and $17 to $18.50 for steel. Chicago: $31.50 to $33; old rails $22 for iron and $14 to $16 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.1 to 2.2 cts.; iron track bolts, 2.7 cts. with square and 2.8 with hexagon nuts. Chicago: splice bars, 1.87½ cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14.25 to $17. Pittsburg: $14.50 to $16.50. Chicago: $14.50 to $17.50.

Lead.—New York: 4.2 to 4.25 cts. Chicago: 4 to 4.2 cts. St. Louis: 4 cts.

Structural Material.—New York; beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to .75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, .95 to 2.15 cts. for tank, 2.2 to 2.3 cts. for shell, 2.45 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.15 to 2.2 cts.; refined bars, 1.9 to 1.85 cts.; steel plates, 2.05 to 2.1 cts. for tank, 2.15 cts. for shell, 2.4 to 2.55 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.1 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.75 to 3 cts. for shell, 3 to 3.5 cts. for flange, to 5.5 cts. for firebox; boiler rivets, 4.25 cts.